

Research Report 1457

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U.S. Tank Platoon Training for the 1987
Canadian Army Trophy (CAT) Competition
Using a Simulation Networking
(SIMNET) System

Ronald E. Kraemer and David W. Bessemer

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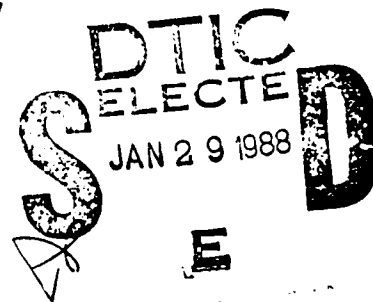
ARI Field Unit at Fort Knox, Kentucky
Training Research Laboratory



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**U.S. Tank Platoon Training for the 1987
Canadian Army Trophy (CAT) Competition
Using a Simulation Networking
(SIMNET) System**

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FOREWORD

The Army Research Institute (ARI) Field Unit at Fort Knox is responsible for conducting research in Armor training and simulation, and human performance in Armor weapon systems. This research investigated the effectiveness of training conducted in a platoon-sized Simulation Networking (SIMNET) system. The U.S. Army Europe (USAREUR) tank platoons practiced battle runs in SIMNET M1 crew modules to prepare for the 1987 Canadian Army Trophy (CAT) competition. Based on direct observation and interviews, this paper reports the conduct and effects of SIMNET training, presents the results of CAT competition for U.S. units, and examines the potential relationships between CAT results and SIMNET training combined with other unit training. This is one of three reports on the CAT competition, others being prepared by the Training and Doctrine Command Analysis Center (TRAC) and the U.S. Army Armor and Engineer Board (USAARENBD).

The ARI research effort was prompted by a request for Technical Advisory Service (TAS) by the Vice Chief of Staff of the Army (VCSA), together with additional requests for assistance by the 7th Army Training Command (ATC), USAREUR, and the Directorate of Training and Doctrine (DOTD), U.S. Army Armor School (USAARMS).

The research findings have been briefed to the VCSA and the other sponsoring agencies, and advance copies of the report were provided for their review. The findings are being used to supplement information gathered in Army test programs that provide the basis for employment of SIMNET systems in training or research and development, and in formulating requirements for future training devices. The results will also be of interest to unit commanders and instructors contemplating the use of SIMNET for collective training, as well as agencies responsible for developing and procuring training devices that involve networked simulators or other technologies related to those applied in the SIMNET system.

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U.S. TANK PLATOON TRAINING FOR THE 1987 CANADIAN ARMY TROPHY (CAT) COMPETITION USING A SIMULATION NETWORKING (SIMNET) SYSTEM

EXECUTIVE SUMMARY

Requirement:

The purpose of this research was to collect and examine evidence concerning the training effectiveness of a Simulation Networking (SIMNET) system in preparing U.S. Army tank units for the 1987 Canadian Army Trophy (CAT 87) competition. The specific objectives of the research were to determine (a) the impact of SIMNET training on CAT 87 performance, (b) SIMNET limitations affecting training for CAT, (c) effective methods of training in SIMNET, and (d) factors other than SIMNET influencing CAT results.

Procedure:

Training observations were collected from each U.S. CAT unit during two formal training periods in SIMNET. These included pretraining in SIMNET by contract personnel from Defense Advanced Research Projects Agency (DARPA) and SIMNET training conducted by CAT unit leaders. Informal interviews were conducted with company commanders, platoon leaders, and tank crew personnel throughout these training periods. Also collected were company training schedules, tank platoon rosters, and fire distribution plans made available by the CAT units. Official CAT performance scores were obtained for all platoons both during and following the competition.

Findings:

Based on direct observation of SIMNET training and subsequent examination of available data on platoon performance in CAT, it appears that SIMNET training may have made a major contribution to the performance of these U.S. CAT units by (a) helping them develop and improve their fire distribution plans, and (b) helping platoon leaders develop the command, control, and communication (C³) skills to effectively execute those plans during CAT platoon battle runs. Major factors other than SIMNET training that may have affected CAT outcomes were (a) conducting live-fire battle runs using either subcaliber or main gun ammunition and (b) tank crew gunnery training on the M1 Unit Conduct of Fire Trainer (UCOFT). The most apparent shortcoming in the SIMNET simulation system (one that may have interfered with effective CAT training) was in the simulation of the M1 tank's fire control system. M1 drivers also had some temporary difficulties in using fire control skills in SIMNET, and in maneuvering in platoon formations.

U.S. TANK PLATOON TRAINING FOR THE 1987 CANADIAN ARMY TROPHY (CAT) COMPETITION
USING A SIMULATION NETWORKING (SIMNET) SYSTEM

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U.S. TANK PLATOON TRAINING FOR THE 1987 CANADIAN ARMY TROPHY (CAT) COMPETITION USING A SIMULATION NETWORKING (SIMNET) SYSTEM

INTRODUCTION

The U.S. Army participated in the 1987 Canadian Army Trophy (CAT 87) competition held at Grafenwoehr, Federal Republic of Germany (FRG), during 15-19 June 1987. Three tank companies from different U.S. Army Europe (USAREUR) divisions were selected on 1 April 1987 to compete. Each tank company consisted of three platoons making a total of nine U.S. platoons competing in CAT 87.

This report presents the first author's direct observations of platoon training conducted by the three U.S. tank companies in preparation for the CAT 87 competition. The observations were limited to training sessions using a Simulation Networking (SIMNET) system that simulated the platoon operating environment encountered in CAT battle runs, and were collected during two separate time periods: (a) when the units began their initial training in SIMNET (6-28 April) and (b) later (21 May-14 June) when they completed their final SIMNET training. Some additional information on the unit's training in preparation for the CAT competition was supplied by the unit commanders and staffs, as was data on battle run performance in the CAT competition.

The specific objectives of the research were to address four issues concerning SIMNET training: (a) the impact of SIMNET training on CAT 87 performance, (b) SIMNET limitations affecting CAT training, (c) effective methods used by CAT units training in SIMNET, and (d) factors other than SIMNET influencing CAT results.

This report of CAT platoon training in SIMNET was initiated at the request of the Vice Chief of Staff for the Army (VCSA). Two other reports also are being prepared relating to CAT. A second report, being prepared by the U.S. Army Training and Doctrine Command Analysis Center (TRAC) for the Directorate of Training and Doctrine (DOTD), (USAARMC) Fort Knox, KY, provides an analysis of U.S. CAT team biographical data, their subjective opinions of SIMNET for CAT training, and their use of other armor training devices in preparation for the CAT competition. A third report on U.S. CAT tank platoon performance as measured during SIMNET training is being prepared by the U.S. Army Armor and Engineer Board (USAARENBD), Fort Knox, KY. All three reports will supplement findings of the Concept Evaluation Program (CEP) Test to be completed by USAARENBD in 1st QTR FY88.

CANADIAN ARMY TROPHY (CAT) COMPETITION

Historical Perspective

The Canadian Army Trophy (CAT) competition started in 1963 when the Canadian Government donated a silver replica of a Centurion tank to the country

that obtained the highest tank gunnery score. Later this tank became known as the Canadian Army Trophy for North Atlantic Treaty Organization (NATO) Tank Gunnery. The land forces of the NATO member countries stationed in the Central Region compete for the trophy. The winner of the Canadian Army Trophy, which remains the property of Canada, retains it until the time fixed for the next competition and is responsible for its safe custody. From 1963 through 1968 the competition was held annually. Since then, the competition has been held biannually during odd numbered years.

The aims of the CAT competition are twofold: (a) to improve the overall standard of tank gunnery within participating forces; and (b) to enable participating teams to meet in a spirit of true comradeship and fraternity.

Since 1963 the competition format has undergone numerous changes. Originally, single tanks fired from fixed points at known ranges. Following the 1968 and again after the 1975 competitions, the rules and procedures of the competition were changed to more accurately reflect combat conditions. The competition now requires tank platoons to fire and move over a course, termed a "battle run," designed to test their gunnery skills under more realistic conditions. Each battle run consists of firing from stationary positions and while on the move, at both stationary and moving targets.

Following the 1981 competition, additional changes were made to provide better means of achieving the aims of the CAT competition and to reflect the intended nature of the event, namely, a competition among the land forces of the Central Region. Accordingly, the 1983 CAT competition format organized units from the six participating nations (Belgium, Canada, Germany, Netherlands, United Kingdom, and the United States) in teams corresponding to their army group assignments within the Central Region. Units were therefore either members of the Central Army Group (CENTAG) or Northern Army Group (NORTHAG). The Canadian Army Trophy for NATO Tank Gunnery is now presented to the winning Army Group Team.

Following the success of the new concept, national hosting of the competition was ended in 1985 and the responsibility for holding alternating competition given to the Army Group Headquarters. At CAT 85, the CENTAG Commander agreed to host the 1987 CAT competition.

CAT 87 Rules and Conditions

The 1987 Canadian Army Trophy (CAT) Competition Rules and Conditions are provided in Appendix A. Several salient aspects of that document are presented below.

Administration. The CAT Competition Committee of Control (CATCC), chaired by Headquarters, Allied Forces Central Europe (HQ AFCE), plans and supervises the competition. The Host Army Group (CENTAG or NORTHAG) conducts the competition according to the CAT Rules and Conditions and the guidance of the Commander in Chief, Allied Forces Central Europe (CINCENT). The Host

Army Group, in liaison with the AFCENT Project Officer and other CATCC members as appropriate, coordinates all the arrangements for the competition, including the reception of the teams and the Opening and Awards Ceremonies.

Platoon Selection. Designated samples of tank platoons from NORTHAG and CENTAG competed in CAT 87 with the winning Army Group determined by the aggregate score of the platoons comprising each Army Group Team. Team composition for NORTHAG and CENTAG is shown in Table 1.

Table 1

Units Assigned to Army Group Teams

NORTHAG	CENTAG
I (BE) Corps - 2 platoons	II (GE) Corps - 2 platoons
I (BR) Corps - 3 platoons	III (GE) Corps - 2 platoons
I (GE) Corps - 2 platoons	V (US) Corps - 3 platoons
I (NL) Corps - 2 platoons	VII (US) Corps - 3 platoons
2 (US) AD (Fwd) - 3 platoons	4 CMBG - 2 platoons
<u>Totals: 5 companies/12 platoons</u>	<u>5 companies/12 platoons</u>

For CAT 87, each Army Group Corps designated a minimum of two companies, each from a different battalion and each separate Brigade, forming a pool of eligible units. A list of the designated tank companies was provided to HQ AFCENT no later than 1 January 1987. A complete company roster (by name, service number, and duty position) was also submitted to HQ AFCENT for each company in the pool no later than 27 March 1987. On 1 April 1987, HQ AFCENT made a random selection of one eligible tank company for each Corps to compete in CAT 87.

U.S. Participating Units. Three tank companies representing the U.S. land forces in the Central Region were randomly selected from a pool of six U.S. tank companies by HQ AFCENT on 1 April 1987 to participate in the 1987 Canadian Army Trophy (CAT) Competition. These tank companies, consisting of three platoons each, were the following units: (a) Delta Company, 4/8 Cavalry Squadron, 3rd Armored Division, (b) Alpha Company, 3/64 Armor Battalion, 3rd Infantry Division, and (c) Delta Company, 2/66 Armor Battalion, 2nd Armored Division (Forward). Two of these units (D/4/8, A/3/64) are assigned to CENTAG with the third unit (D/2/66) assigned to NORTHAG.

Selection of individual tank crewmen for the CAT competition was performed throughout the train-up period by each participating unit using a variety of measures. Typically, tank commanders (TCs) and gunners (GRs) were chosen based on their prior Tank Table VIII gunnery results and M1 Unit Conduct of Fire Trainer (UCOFT) performance. Additional factors such as (a) mental ability as measured by the Armed Services Vocational Aptitude Battery

(ASVAB), (b) supervisor judgment of a soldier's self-discipline, attitude, and desire to participate, and (c) previous CAT competition experience were used in the selection process for all crewmembers.

The principal tank crewmen selection criterion under the CAT Rules and Conditions was that TCs and GRs who participated in the preceding CAT could not compete in the same tank duty position. A final list of personnel who were to compete was to be handed to the Chief Judge, on the Friday prior to the competition. From that time, no changes could be made to the list, except as indicated in the CAT Rules and Conditions for the use of nominated team reserves.

All CAT participants completed a biographical questionnaire. This questionnaire was administered by members of the TRADOC Analysis Command (TRAC) located at Grafenwoehr, FRG as part of a larger attitudinal survey directed toward the use of SIMNET and other training devices used during their pre-competition training.

Training Restrictions. Pre-competition training restrictions were imposed by CATCC on all units placed in the CAT competition pool. Of these, the two more important restrictions were:

1. "Competition range will be OUT OF BOUNDS to all companies in the pool that were designated on 1 January from that time until the competition."
2. "Total main armament ammunition expenditure for designated tank companies will not exceed 134 rounds per crew from 01 October 1986 to the competition in June 1987."

Conduct of CAT Battle Runs

Judging. Judging of the competition was done by the Chief Judge and a panel of national judges. Each nation provided two judges, neither of whom were members of the Committee of Control nor members of a competing team. During each battle run, the judges filled in score sheets, and applied the scoring to determine the platoon score. After each battle run, the judges went down the range to confirm the hits on all main gun and machinegun targets. They then completed a Judges' Platoon Score Sheet and handed it over to the Committee of Control.

CAT Battle Run Scenarios. The target engaged during the competition were painted flat black and all had the same size and shape as shown in Figure 1. The main gun targets were static or moving, and the moving targets were presented in head-on, oblique or flank orientation. Heating devices were affixed to the targets, with additional heating devices deployed as decoys. The heating devices permitted the use of thermal sighting equipment to detect and engage targets. The number of targets presented in CAT 87 were 24 for platoons with three tanks, and 32 for platoons with four tanks, so that regardless of size, all platoons encountered an average of eight targets per tank crew.

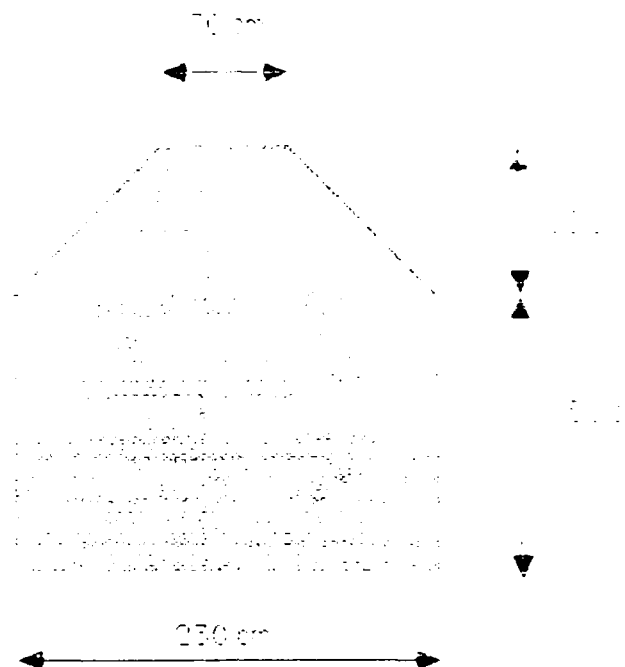


Figure 1. Size and shape of CAT Battle Run main gun targets.

Targets were engaged by the main gun from three stationary firing positions, termed "bounds", and during two moves between bounds. Eight groups of ten falling plates, two groups per firing lane, were also presented to each platoon for engagement by machine gun. The falling plates were to be engaged on the move from Bound One to Two and Bound Two to Three.

A minimum of twelve different target layouts and two spare layouts for reruns were prepared by the Chief Judge. Each layout comprised as a minimum:

1. Five main gun engagements distributed during the battle run including:

- (a) two engagements with both static and moving targets, and
- (b) one engagement with six or eight targets depending on platoon size.

2. Two main gun engagements while the vehicles are on the move against both moving and/or static targets.

Only one tank platoon from each of the Army Group Teams encountered each of the twelve target layouts so that within Army Group Teams, every tank platoon had a different battle run scenario. In the interest of fairness, information regarding the layout of the competition range was withheld from

the competing teams. Also, the particular battle run scenario selected for a given platoon was drawn by lot on the evening of the preceding day, at the earliest.

CAT Battle Run Scoring. The scoring system for main gun targets was based on a significant number of points for achieving target hits, with a lesser number for speed of achieving hits. Also, if all main gun targets were hit, a bonus score was given for targets hit and ammunition remaining. machine gun (MG) scoring was based on the number of targets knocked down. Table 2 outlines the allocation of points that would result in a perfect platoon battle run.

Table 2

Maximum Possible Scores for CAT Battle Run

<u>Component Score</u>	<u>Points</u>
Hit Score	10,000
Time Score	8,500
Hit Bonus	500
Ammunition Bonus	1,600
Machine Gun Score	2,000
Total Score	<u>22,600</u>

The following definitions were employed in scoring the competition:

1. Successful Engagement: A successful engagement was one in which there was at least one hit on a target within the time limit laid down. This did not include splinters or ricochets. In cases of doubt, the Chief Judge had absolute discretion.

2. Time Limit: This was the period of 40 seconds for the main armament targets, measured from the time that targets were fully upright. Any shot fired outside the time limit was ignored in the scoring of that battle run.

The scoring formulas used to compute main gun and machine gun scores are presented in Appendix A. Also included are the penalties for not arriving at a bound on time and using reserve ammunition without authorization.

CAT Battle Run Procedure. The battle run procedure for competing tank platoons was standardized by the Host Army Group in accordance with the CAT Rules and Conditions and CINCENT's guidance. Basically, tanks moved from

their assembly area to a zeroing range, then to a waiting area where they established radio communications with the Control Staff and obtained ammunition for the battle run. Each tank stowed 10 practice rounds for the main gun, and a total of 250 rounds of machine gun ammunition. Also, each tank carried a reserve of four main gun rounds and 125 rounds of machine gun ammunition that were to be used only after authorization by the judges.

Once control was established in the waiting area, a national judge ordered the platoon to Bound One. On arrival at the bound line, the tank crews loaded their weapons and prepared to execute the battle run. The tank platoon was then presented a group of 1-8 main gun targets for a maximum of 40 seconds. After this target engagement, a second group of targets could have been presented as long as the total number of targets presented at a bound did not exceed six (for a three-tank platoon) or eight (for a four-tank platoon).

When no more targets were to be presented at Bound One, the tank platoon was ordered to move to Bound Two. During this movement they engaged both main gun targets and the machine gun falling plates without halting and within a specific period of time representing an average speed of 10 mph.

This sequence was repeated at Bound Two, during movement to Bound Three, and again at Bound Three. When the platoon completed the last engagement at the third bound, they were ordered to clear all tank weapons. A Safety Officer then checked all weapons and ammunition, after which a control team checked the ammunition consumed during the battle run. The platoon remained at Bound Three until directed to return to its assembly area by the national judge.

Misfires or mechanical failures that occurred during a platoon battle run were considered a warlike hazard which, subject to the maintenance of safety, did not in any way influence the continuation of the battle run. The Chief Judge had the discretionary power to stop any engagement at any time. Protests could be lodged with the Chief Judge after the termination of the battle run. For the conduct of the battle runs, the Chief Judge's decision was final.

Termination of CAT Competition. The end of the CAT competition is declared on the last scheduled day, even though all tank platoons might not have had the opportunity to fire. In such a case, a final team score is computed based on the scores earned by the maximum equal number of platoons in the order they competed per Army Group Team. In CAT 87, all twenty-four platoons completed their battle runs.

CAT 87 Firing Results

The Tankers of the Spearhead Division's 1st Plt, Co D, 4th Bn, 8th CAV took top platoon honors in the competition. This was the first U.S. unit to earn that distinction in the 24-year history of the event. This tank platoon successfully engaged all 32 targets presented during the battle run to obtain a perfect hit score (10,000 points) and the accompanying 500 point hit bonus.

In addition, they hit 77 of 80 machine gun plates to earn 1925 points, and returned five allocated main gun rounds for 500 ammunition bonus points. Their hit times yielded a time factor of 14% corresponding to a time score of 7565 points, thus resulting in a total score of 20,490 out of a possible 22,600 which was well above any other U.S. or NATO tank platoon.

Three of the U.S. tank platoons ranked relatively high (1, 3, and 7) in the competition, with the remaining six platoons clustered at or just below the center of the score distribution. There were no U.S. platoons in the lowest 25% of the 24 competitors. Comparing the performance measures among platoons, the differences in percent of targets hit (See Figure 2) are fairly small, while the time variations (See Figure 3) appear to be relatively greater. However, the total scores shown in Figure 4 tend to weight hits more than time, and thus relate more directly to the former factor. Machine gun performance varied little among the platoons with no plates missed by six platoons, and only 1, 2, or 3 missed by the remaining platoons. The complete results for NORTHAG and CENTAG tank platoons are presented in Appendix B.

It is interesting to note that the rank order of U.S. platoon scores correlated highly with the order of completion of the platoon battle run, indicating that the later the platoon fired in CAT, the higher the score. The Spearman rank order correlation was $p = -0.74$, statistically significant with $p < .05$. The meaning of this relationship is highly ambiguous, since at least two alternative interpretations may account for the result. Either the later-firing platoons were profiting from the experience of the earlier platoons, or the unit commanders arranged their best platoon to fire last, and worst platoons first in the positions assigned to the company in the firing sequence.

Average performance measures and scores for the U.S. tank companies that participated in the 1987 CAT competition are shown in Table 3. Although the small number of platoons precludes any effective statistical comparison among companies, the overall averages for D/4/8 CAV are somewhat better than the averages for the remaining companies, and two out of three platoons ranked relatively high in the competition. The order of the platoon battle runs did not favor one company over another, since each had a platoon that fired early, in the middle, and late in the competition. In the remainder of this paper, other possible factors that may have contributed to marginally superior performance in this company will be pointed out.

Meteorological Effects. During the week of CAT competition (14-19 June), the weather was cold and unseasonably rainy with moderate improvements occurring throughout the day. At times, heavy rain and hail with high winds would result in near zero range visibility. At other times, the overcast sky would clear which markedly increased target visibility in the range area. Target obscuration problems associated with propellant smoke, or with dust raised by rounds impacting short of targets were virtually non-existent.

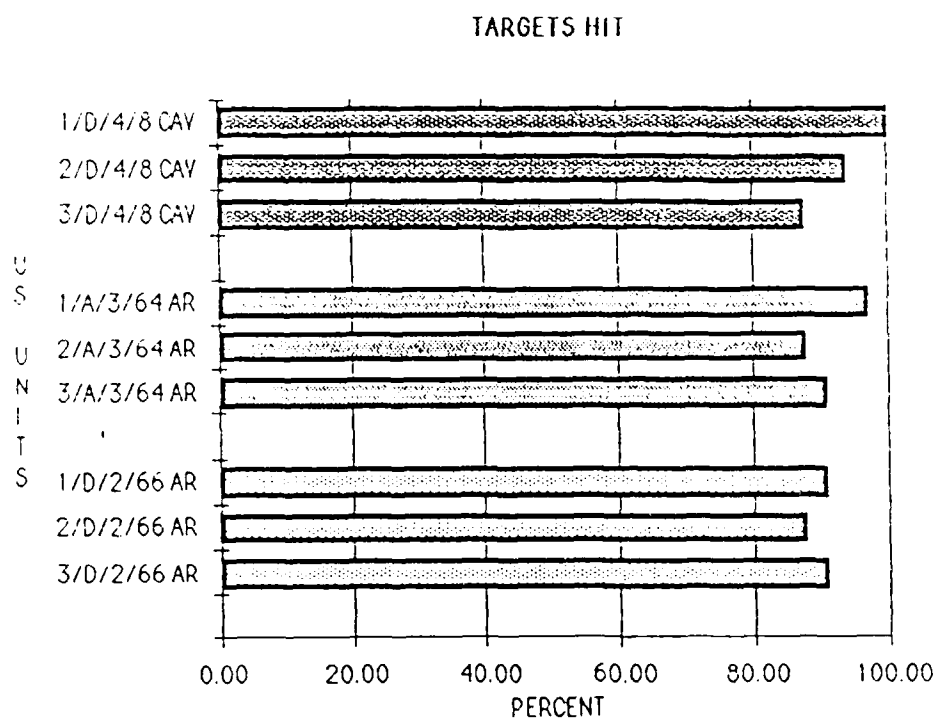


Figure 2. Targets hit (percent) by U.S. units.

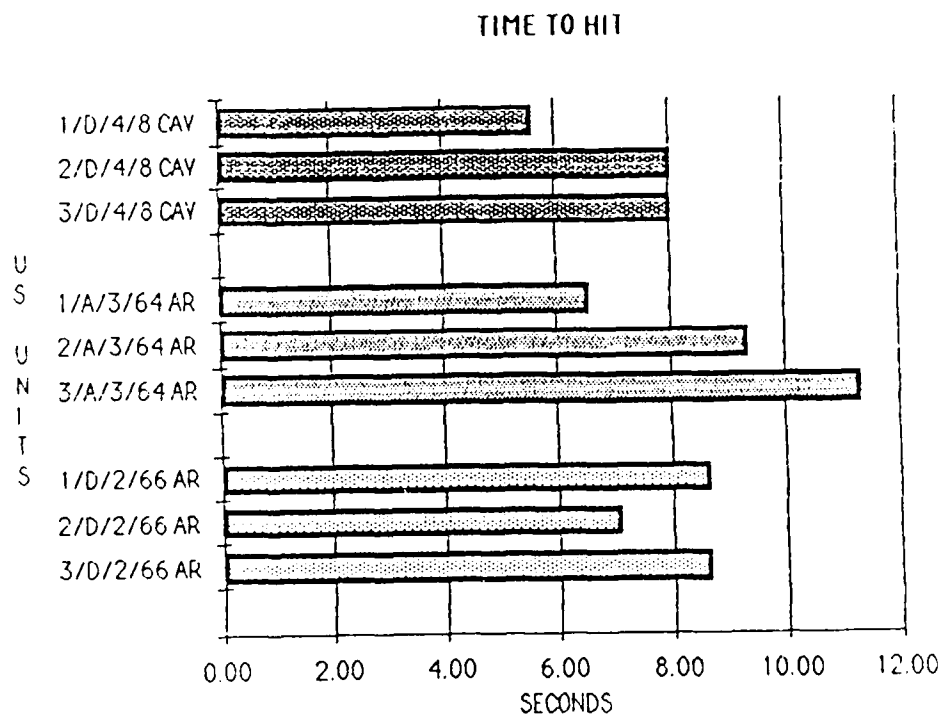


Figure 3. Time to target hit (seconds) by U.S. units.

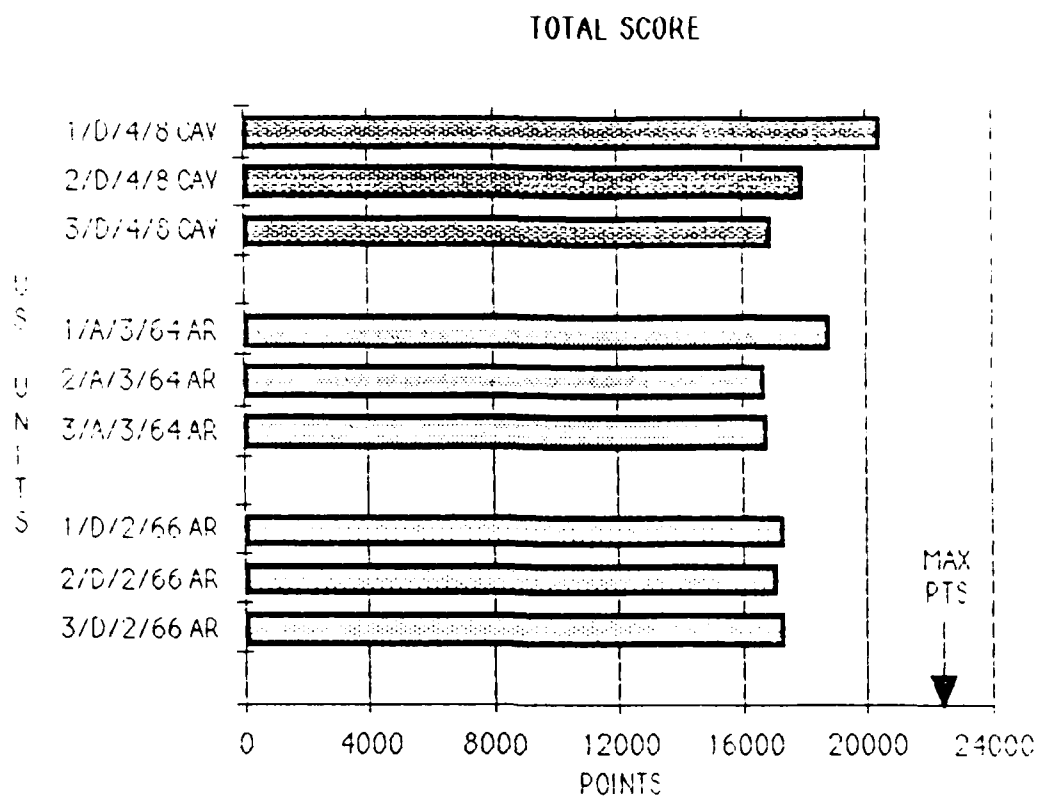


Figure 4. Total Score (points) by U.S. units.

Table 3

CAT Performance of U.S. Army Companies

Companies	Targets Hit (Percent)	Average Time to Hit (Seconds)	Total Score (Points)
D/4/8 Cav	93.75	7.20	18475
A/3/64 AR	91.66	9.08	17440
D/2/66 AR	89.58	8.14	17276
U.S. Average	91.66	8.14	17730

Weather conditions did significantly affect the battle run performance of one U.S. CAT unit; namely, the third platoon, D/4/8. When the platoon arrived at Bound One to begin its competition run, the skies were dark with light falling rain. These conditions continued up to Bound Three, when suddenly they encountered very heavy rain and near zero visibility. At that time, the platoon had fired 28 main gun rounds and successfully engaged all 28 targets. They also hit 79 out of 80 machine gun plates presented between bounds.

In past CAT competitions, similar bad weather conditions resulted in a battle run being temporarily delayed by the Chief Judge until conditions improved. Unfortunately, the decision was made to complete the run and the four remaining main gun targets were presented for the final engagement. In that 40 second time period, none of the targets was acquired.

After a protest was considered and rejected, what could very well had been a high score resulted only in an average score of 16,930 points. Given a continuation of the performance on the first 28 targets, this platoon could have scored up to 20,075 points including the hit and ammunition bonuses. In that case, the platoon would have taken third place and the average results for D/4/8 CAV (19,523 points) would have outpaced the other U.S. companies by a very substantial margin.

The weather conditions during the CAT competition battle runs for the remaining U.S. CAT platoons did not adversely affect their performance any more than it did the other NATO tank platoons. In fact, the weather conditions during the winning tank platoon battle run (1st platoon, D/4/8) and the third highest scoring platoon among the 24 competitions (1st platoon, 1/3/64) were excellent. It wasn't raining, the skies were cloudy but clear, and targets presented were clearly visible in the range area.

OBSERVATIONS ON SIMNET TRAINING

SIMNET Simulation System

Project Overview. The Simulation Networking (SIMNET) project seeks to develop and demonstrate the technology base for large-scale systems of computer-based, relatively low-cost, interacting weapon system combat simulators. The M1 Abrams tank and M2/3 Bradley Fighting Vehicle were chosen for the initial development of a simulation testbed representing a land battle environment. The full SIMNET development effort managed by the Defense Advanced Research Projects Agency (DARPA) is summarized in Appendix C. The technical objectives of the project are outlined in Appendix D.

Configuration for CAT Training. Major components of the SIMNET system provided for CAT training are illustrated in Figure 5. Four M1 tank simulator modules were interconnected by an Ethernet local area network (LAN) (see Pope, 1987). Each module consists of driver and turret compartments representing the spaces, station controls, and instruments used by M1 crewmen during closed-hatch tank operations. The modules have a self-contained host microcomputer and a graphics processor that communicate with the network, process data on control inputs, vehicle status, remote vehicles, and terrain data, send signals to instruments, and present visual images on displays to show crewmen views of the external world through eight simulated vision blocks and sights. Software functions driving the SIMNET modules are described in Chung, Dickens, O'Toole, and Chiang (1987). Each module has internal crew communication capabilities over headsets substituting for those found in the tank. Operation of the crew controls, instruments, and displays is described in the M1 SIMNET Operator's Guide (U.S. Army Armor School, 1987).

For the purpose of CAT training, the M1 simulator modules were each supplied with a terrain data base representing the CAT competition range, i.e., Range 301 at Grafenwoehr, FRG. The SIMNET terrain closely represented the land forms on the range as well as the exact locations of tank firing positions and lanes. Since the SIMNET modules do not yet simulate machinegun firing, only main gun target panels were displayed. SIMNET computer image generation is described further in Illing (1987) and Cyrus (undated).

The Management, Command and Control (MCC) subsystem contains an MCC host computer and operator console linked to the Ethernet network, and linked to an Appletalk network of seven Apple Macintosh microcomputers. One Macintosh serves as a bridge interface to the host, and a second provides the SIMNET Control Console (SCC) used to initialize the location and condition of the simulated tanks for an exercise, and to activate the crew modules. The third Macintosh serves as the Range Master Console, used to select, control, and monitor exercise scenarios, and to enter unit and personnel identification information used on the performance printout. The four other Macintoshes serve as Fire Support, Close Air Support, Admin/Log, and Maintenance consoles representing a Tactical Operations Center (TOC). The TOC consoles were not operated during the CAT practice sessions, except when the platoons participated in free play exercises. SIMNET modules and the TOC have hardwired

Grafenwoehr Site March 1987

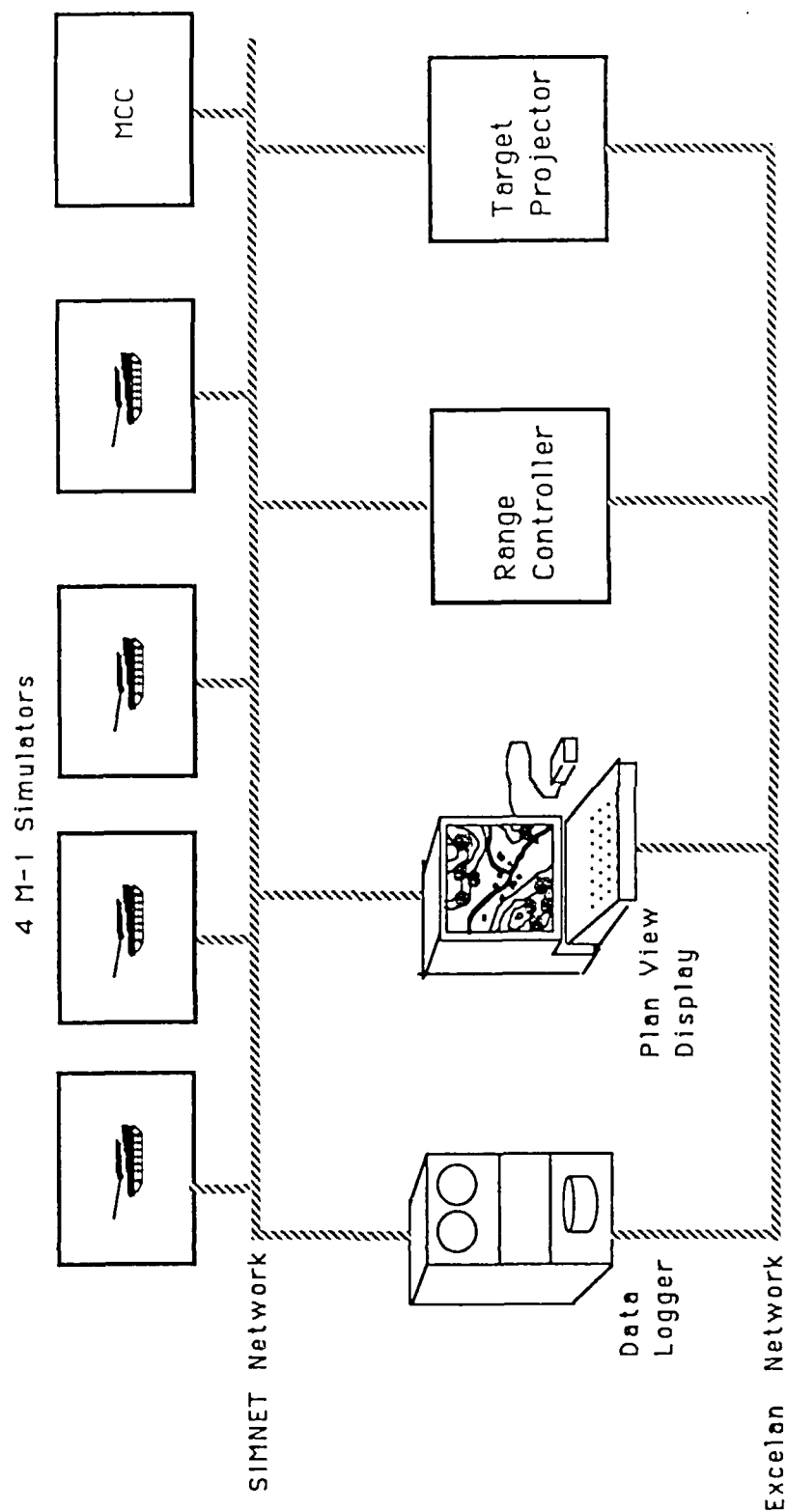


Figure 5. Major components of the SIMNET system.

40-channel CB radios used to simulate all of the normal tactical FM radio networks. The MCC host holds terrain information, processes inputs from the SCC and TOC consoles, and transmits data packets over the networks to initiate and control events associated with these inputs at the proper locations. Pope, Langevin, and Tosswill (1987) present detailed descriptions of the functions and operation of the MCC.

A second (Excelan) network connected the Plan View Display (PVD), Data Logger, Range Controller terminal, and Target Projector terminal. A MASSCOMP computer and printer (not shown) processed inputs from these components, transmitted data packets, and provided printouts of performance data. The PVD presented a graphic map overview of the terrain, showing the positions, movement, and firing of vehicles in real time during exercises and during replay for after-action review (AAR). The Data Logger recorded, on disk and tape media, the stream of data packets passed on the Ethernet LAN during exercises, and retrieved stored data for processing by the MASSCOMP and for replay on the PVD. Data tape records of the exercises were kept for subsequent data analysis at the Fort Knox SIMNET-D facility. The Range Controller terminal station was used to construct, initialize and operate target presentation scenarios. (The 27 scenarios used in SIMNET did not duplicate those used in the competition, but were constructed to conform to the CAT rules.) The Target Projector terminal activated target presentations in response to inputs from the Range Master. Both terminals translated inputs from the Range Master, and operated through the MASSCOMP to transmit data packets to the M1 modules producing events on the simulated CAT range.

At the request of CAT company commanders, four SONY TV monitors were installed near the Range Master station to monitor GR performance during platoon battle runs. Later on, plastic reticles were taped to each monitor to observe GR aim. About the same time, audio tape-recorders were used to record tank radio communications for playback with the PVD during AARs.

Facilities. The SIMNET training facility was located in Building 2208 at Camp Aachen, 7th ATC, Grafenwoehr, FRG. A diagram depicting the general layout of the facility is shown in Figure 6. Basically, the rectangular shaped building contained six major areas: (a) an area for the M1 crew modules, (b) an instructor-controller area for supervising training and conducting AAR sessions, (c) an administrative area for both site operations and management, (d) a Tactical Operation Center (TOC) supporting force-on-force exercises, (e) a computer center containing ancillary equipment including the data logger and printer, and (f) the maintenance support area. A troop holding area was used to control access to the facility and was located in a corridor connecting the facility entrance to an adjacent building.

SIMNET Pretraining

CAT units were pretrained in SIMNET to acquaint them with the operation of the crew stations and the battle simulation effects presented during platoon missions. The pretraining was conducted by DARPA contract personnel during the initial day of SIMNET training scheduled for each of the

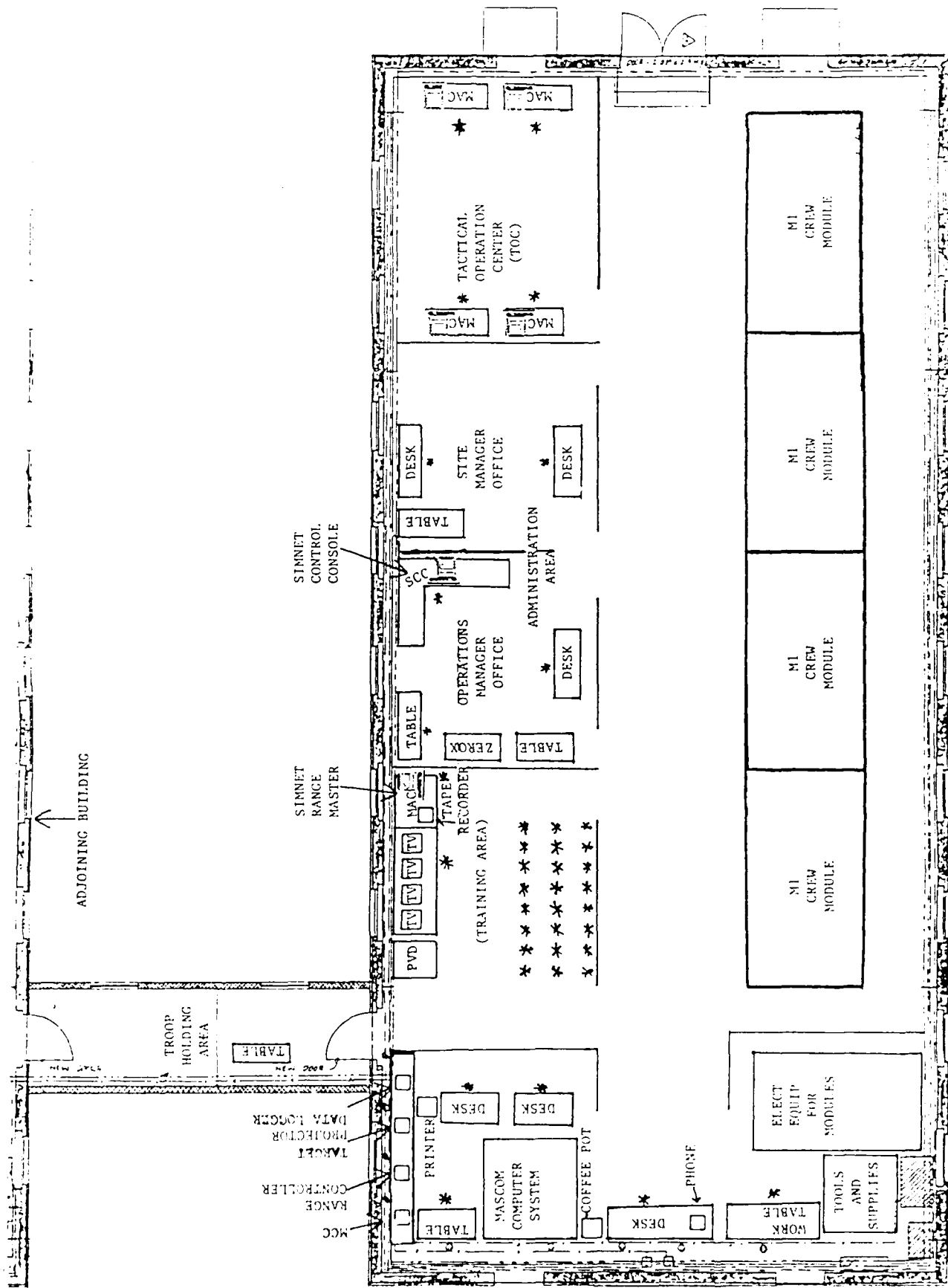


Figure 6. Diagram depicting the general layout of the SIMNET training facility at Grafenwoehr.

U.S. CAT units. Since the SIMNET facility only had four M1 tank simulators, the companies scheduled SIMNET training in three four-hour time blocks; one time block for each tank platoon. Platoons not being trained on SIMNET were scheduled for either concurrent UCOFT training or tank maintenance.

Pretraining began with the company's TCs followed by pretraining for individual tank crews assigned to each platoon. The procedure used to pre-train both groups was very similar. As each training group arrived at the SIMNET site they were shown a ten-minute video-cassette recording that described SIMNET's capabilities and future plans for conducting combined arms tactical training. This was followed by a brief overview of administrative requirements by the site managers and a question-answer period. The training groups were then placed in the M1 simulators where they received individual training on SIMNET controls and functions. Specifically they were instructed on how to start the simulator, operate the commander's cupola, use the SIMNET radios, determine grid azimuth and gun tube position, operation of switches and controls in gunner and driver stations, and how to load, unload, redistribute, transfer and rearrange ammunition. Following these instructions, the TCs formed four-man tank crews and were allowed to move, shoot, and communicate in a free-play simulated combat environment.

While TCs were being trained on the M1 simulators, the company commander and selected staff personnel received individual training on how to conduct SIMNET training. This included operating the SIMNET Range Master console to select and control simulated CAT battle runs, and using the PVD to record and replay platoon battle runs during the AAR. The unit's CO and staff were also trained on how to create their own platoon battle run scenarios using the SIMNET Control Console.

To complete their pretraining on SIMNET, the training groups conducted platoon battle runs followed by AARs. The battle runs provided initial practice in driving from a designated assembly area to their assigned firing lanes at Bound One, completing the target engagements presented at and between Bound One to Bound Three, and driving back to the assembly area. The AARs provided training groups the opportunity to observe both their driving and tank gunnery performance during the battle runs on the PVD.

The pretraining of personnel on SIMNET varied across the three tank companies. The first company to train on SIMNET, D/2/66 lost considerable training time demonstrating SIMNET capabilities to visiting high ranking officers and civilians. This unit also encountered numerous equipment failures as the M1 simulators were being used for the first time. The next unit, D/4/8, experienced fewer training interruptions and spent more time learning how to operate SIMNET equipment for CAT training purposes. The pretraining received by the third unit, A/3/64, was frequently disrupted by repeated failure of SIMNET equipment.

Other observations indicate that SIMNET pretraining was inadequate in particular areas. Company personnel did not operate the SIMNET consoles properly in conducting simulated battle runs, usually making one or more serious errors. Such errors included (a) entering the wrong tank bumper numbers at either the Range Master Console or SIMNET Control Console which

resulted in loss of the computer printout, (b) failure to initialize required ammunition per simulator at the SIMNET Control Console, (c) failure to enter the correct times permitted for tank platoons to negotiate movement between bounds, or (d) allowing a movement penalty to occur when such a penalty was not warranted. They also did not use the capabilities of the PVD to provide adequate training feedback to the tank crews concerning their battle run performance. Without more specific training on how to use the capabilities of the PVD, they simply replayed the battle run and commented on obvious errors as they occurred. How to use the computer printouts to augment the AARs was never discussed.

Conduct of Training

Procedures. CAT companies conducted SIMNET training with little additional instructions or guidance from DARPA contract personnel after the one day of pretraining. Tank platoons arrived for training and immediately entered the M1 simulator modules to practice SIMNET platoon battle runs with terrain and targets simulating the CAT Range 301. Since similar exercises were conducted repetitively, little or no new instruction or guidance was given by the company commander before the crews entered their modules and began their battle run. Selection of platoon battle runs or scenarios was made by the company commander or personnel assigned by him as instructor/controller to conduct SIMNET training. For D/2/66 and A/3/64 most of the SIMNET training was under control of the company's executive officer or platoon leaders, respectively. SIMNET training for D/4/8 was conducted almost exclusively by the company commander.

After all TCs reported that their crews were in position, usually at Bound 1, the company controller started the SIMNET battle run. The battle run was terminated when all engagements were completed at Bound Three. Occasionally, the battle run was stopped prematurely by M1 module malfunctions, or by decision of the company controller. In the latter case, some serious confusion or performance deficiency was observed that required immediate correction and that made continuation of the battle run unproductive.

Fire Distribution Plans. During SIMNET platoon battle runs, tank crews engaged targets in accordance with their unit's fire distribution plan. Basically, D/2/66 employed a grid system whereby the range was divided into four tank sectors and three target distances; near, mid, and far. The platoon leader and platoon sergeant occupied the two center tank positions with their wingmen located on their outside. The wingmen scanned and engaged targets in their sectors from far to near and from outside to inside, while the platoon leader and platoon sergeant searched and engaged targets in their tank sectors from near to far and inside to outside. When the wingmen completed scanning or engaging targets in their tank sectors, they repeated the procedure for targets in the platoon leader's or platoon sergeant's sector, and vice versa. Based on the configuration or layout of Range 301, D/2/66 also used sectional cross fire during the movement from Bound Two to Three i.e.,

the platoon leader and his wingman covered the entire range until the other section of two tanks completed their machine gun engagements and were cleared to fire. At that time, the two sections would switch responsibilities.

The fire distribution plan employed by D/4/8 was initially quite similar to that of D/2/66. The only two exceptions were that (a) the platoon leader and platoon sergeant were reversed, i.e., the platoon sergeant was located to the left rather than right of the platoon leader, and (b) the wingmen were tasked to engage all moving targets. Based on the results of live-fire battle runs on Range 117 and SIMNET training, the company commander decided to modify their fire distribution plan to include target memorization. In doing so, the unit renumbered the existing Range 301 target numbers and then assigned target numbers to each tanks firing sector in sequential order from near to far. Each tank crew was then required to memorize the sequential list of numbers and target locations that it was responsible for engaging during the CAT battle run. The crews participated in frequent verbal rehearsal and testing sessions to reinforce quick recall of their target responsibilities by every crewman.

As of this report date, the fire distribution plan for A/3/64 has not been made available to ARI. From the first author's observation, this unit also employed a target memorization strategy by modifying existing Range 301 target numbers. Instead of numbering assigned targets sequentially by tank sectors, the target numbers were modified by referring to targets as left or right of a base target. For example, if target number 40 was the base target, targets 39 and 41 were referred to as left 40 and right 40, respectively. The unit's fire distribution plan also positioned the platoon leader and platoon sergeant in the outside two tanks with their wingmen on the inside tanks. This was markedly different from the two other CAT units. In conducting a battle run, each tank fired in its sector at Bound One with the range divided by target numbers. During movement from Bound One to Two and at Bound Two, the tank sections cross fired, with the platoon leader and platoon sergeant tanks engaging the far targets and their wingmen the near targets. Target numbers were always used when describing target location, and whether tanks engaged targets far to near or near to far was left up to each platoon based on the strengths and weaknesses of its GRs. During movement from Bound Two to Three, the left tank section (Alpha) covered the entire range while the right section (Bravo) engaged their machine gun plates. As soon as the plates were knocked down, the tank sections immediately switched target responsibilities. Unlike D/4/8, the company commander indicated that no major changes were made to its fire distribution plan as a result of SIMNET training.

Instructor Monitors and Audio Recorders. During the conduct of SIMNET training, two training features were added at the request of the company commanders. First, individual TV monitors were hooked up to each tank simulator and positioned on the table directly in front of the controller personnel conducting SIMNET training. Using these monitors, the company controller identified how the individual tank GRs were scanning their sectors, whether they detected targets that appeared in their sectors, and when targets were engaged. Later on, a plastic reticle was taped to the front of each monitor to better indicate where the tank GRs were aiming. The second addition to

the SIMNET training environment was the use of an audio cassette recorder to record the platoon's radio transmissions during a battle run. Replay of the audio recording was used by the controller to accompany and support the video replay provided by the PVD.

Action-Action Review (AAR)

Plan View Display. During the units' initial SIMNET training period, the tank crews left their simulators on completion of a platoon battle run and gathered around the PVD for an AAR by the company controller. In doing so the tank crews simply watched the video playback presented on the PVD with only occasional feedback provided to them concerning their performance. During their final period of SIMNET training the units had changed their training approach, usually completing two battle runs before conducting an AAR. This approach saved time spent getting in and out of the SIMNET modules, and having crewmen assemble at the PVD. As the controllers became more knowledgeable and experienced in using the capabilities of the PVD, the quantity and quality of training feedback also improved. The PVD replay was frozen when targets appeared before engagement and the tank crews questioned as to who was responsible for engaging each of the displayed targets. The PVD replay was then restarted to confirm or reject their responses. When necessary, engagements were replayed to resolve doubts or conflicts and to discuss the unit's fire distribution plan. Additionally, the controllers began (a) zooming in on tank-to-target engagement areas to better judge platoon alignment during tank movement, (b) increasing the size of the tank icons to assess tank crew scanning procedures, (c) isolating individual tank icons to determine number of rounds remaining, (d) isolating targets presented to identify target overkills and targets not engaged, and (e) conducting intervisibility checks to identify targets that were reported as not seen by a tank crew.

Computer Printout. The SIMNET computer printout provided a summary of the platoon's final score for a battle run, a summary of platoon performance in terms of targets engaged, hits, and times for firing at or during movement between bounds, and a further breakdown of that summary by individual tank crews. Essentially, it was a record of the platoon's gunnery performance based on the scoring formulas established for CAT 87.

The SIMNET computer printout provided after each platoon's battle run was used initially by the company controllers during the AARs. However, as the use of the PVD capabilities increased, the printout was disregarded for most of their subsequent SIMNET training. Two principle reasons were given by the company commanders for not using the computer printout. First, DARPA personnel clearly informed the CAT units that SIMNET was not a gunnery trainer. The primary purpose of SIMNET was to enable the units to practice their fire distribution plan by conducting simulated CAT battle runs. Secondary purposes were to familiarize the tank crewmen with the layout of the CAT competition range, Range 301, and the possible location of main gun targets. Thus the PVD rather than the computer printout provided information more directly pertinent to these objectives. Secondly, CAT unit commanders repeatedly instructed their tank crews not to use SIMNET as a tank gunnery device. They

told them to concentrate on acquiring and engaging all the targets presented during a battle run using their fire distribution plan. Whether the targets were hit when engaged was not important. In fact, tank crews were frequently told not to reengage targets during a battle run. The CAT based scoring scheme was meaningless under these conditions, and therefore the information in the printout was not useful during AARs.

Battle Run Performance

Since the computerized scoring of the SIMNET battle runs based on the CAT scoring formula was not appropriate, and the scores uninterpretable, these data were not analyzed and are not included in this report. Only the direct observations of the first author are presented here. A later and more appropriate analysis of SIMNET battle run records will be reported by the U.S. Army Armor and Engineer Board (USAARENBD).

The three U.S. CAT units began their initial period of training in SIMNET, approximately two months before the CAT competition. It was apparent from their initial performance that considerable more training was needed to get them ready to compete. First of all, it was apparent that tank crews were not conducting SIMNET battle runs according to their units' fire distribution plans. Tank GRs were observed (a) not scanning or acquiring targets that appeared in their sectors of fire, (b) double engaging targets in each other's sectors, and (c) engaging near targets first rather than far targets. Also, the tank section assigned to engage main gun targets first during a movement between bounds was often observed engaging machine gun plates instead. Secondly, TCs failed to report (a) the number of targets serviced during an engagement, (b) the number of main gun rounds remaining after an engagement, (c) when they were set or positioned at a bound, and (d) when they needed help to engage multiple targets in their sectors. When they did report, the radio transmissions by the TCs were often fragmentary and distorted. TCs were reporting simultaneously, thereby interrupting or stepping on each others transmissions. Thirdly, tank drivers had difficulty staying abreast or on-line with one another during movement between bounds, and were not observing and recording the number of targets engaged by their tank during a battle run. No serious problems were observed in tank loader performance.

When the three U.S. CAT units were observed during their final period of training in SIMNET, approximately five weeks later, most of the earlier performance deficiencies were noticeably corrected. Significantly fewer targets were not being engaged or double engaged by the tank GRs during the SIMNET battle runs. Targets were rapidly acquired and quickly engaged according to the units' fire distribution plans. In particular, the use of cross fire by tank sections at or during movement between bounds was very much improved, with tank sections having no problems regarding target engagement responsibilities during movement. Also, tank drivers were meeting the time limits established for movement between bounds and were much better at staying on-line with one another during these movements. Apparently, intervening training conducted at home station and on live-fire ranges, plus additional SIMNET training, succeeded in reducing these problems.

The single most noticeable improvement observed at this time was the command, control and communication (C³) skills demonstrated by the platoon leaders and the teamwork exhibited by the TCs during SIMNET battle runs. Accurate target and ammunition counts were being reported by tank crews with few communication problems over the tank radios. Tank crews that needed help in engaging multiple targets presented in their sector of fire were calling for help and receiving it without delay. There was also little confusion as to which tank crew was to provide help or what specific target(s) was to be engaged when doing so. At this point in their pre-competition training for CAT, morale was high. The CAT units were feeling good about their performance and confident that they would perform well during the competition. Tank crew enthusiasm for further SIMNET training remained high across units, with TCs and GRs demonstrating more positive attitudes than tank drivers or loaders whose roles were more limited during SIMNET battle runs. At the end of SIMNET training, no major differences among the CAT companies were noticeable in these characteristics.

In terms of changes that were observed during SIMNET training, as opposed to those reported above between training periods, two particular changes stand out. First, leaders within the tank platoons progressively took on a more active role during the AAR sessions. More discussions were observed between TCs in defining their sectors of fire, identifying the responsibility for targets not engaged, and reallocating target assignments to improve platoon fire distribution. Second, tank platoons placed more emphasis on firing main gun rounds at all targets displayed during a SIMNET battle run rather than reengaging targets not hit. This observation clearly indicated that SIMNET was being used to train platoon fire distribution in preference to tank gunnery. Platoon battle run scores as shown on the computer printouts were not asked for by tank crews, and tank GR complaints about not hitting the targets became infrequent.

SIMNET Gunnery

Initial Reaction. As noted earlier in this report, DARPA contract personnel informed U.S. Army CAT units that the SIMNET system should be used as a tank platoon fire distribution trainer, not a tank gunnery trainer. Despite this disclaimer, however, most TCs and GRs that used the M1 tank simulators for the first time were not convinced. What they saw and experienced was a tank simulation that contained the essential tank fire control system components and computer generated targets needed to conduct main gun precision engagements using the gunner's primary sight (GPS) or TC's extension (GPSE). The TC could traverse the turret to hand-off a target to the GR or to lay his GPSE sight reticle on the target center of visible mass, track (if tank or target is moving), lase, relay on aim point, steadily track center mass for 2-3 seconds (if tank or target is moving), and fire. If the target was hit, as indicated by a black puff of smoke emitted at the target panel, he could immediately release the palm switches to dump lead and continue to engage other main gun targets or cease fire. Essentially, the same target engagement procedure could be used by the GR. They did not regard lack of TIS or

degraded modes to be a serious deficiency, since the essential features required to practice their CAT fire distribution plans were available.

Reported Problems. After some experience with CAT battle runs in SIMNET, the TCs and GRs became more aware of some limitations of the SIMNET simulation, particularly those that were felt (rightly or wrongly) to hamper their CAT training.

Several gunnery problems associated with the SIMNET fire control system were reported by the tank crews during their AAR sessions. Early in SIMNET training, the tank GRs reported that in order to obtain a hit on distant targets, i.e., targets beyond 2000 meters, they were forced to aim at the top of the target rather than at the center of visible mass. They also reported that laying the GPS sight reticle on small distant targets was very difficult since the targets would either quiver or disappear momentarily as the sight picture moved. This phenomenon of course reflects the fact that edges of objects or any small details are unstable to a degree as the SIMNET terrain imagery is moved across the display. When informed of the problem, DARPA SIMNET contract technicians checked or realigned the gun and fire control system. Nevertheless, during subsequent AARs, tank GRs continued reporting unstable distant target images and the need to aim high.

Follow-up discussions with SIMNET technicians indicated that they were aware of certain system gunnery biases beforehand and that a new terrain data base was being developed to eliminate the problem. Unfortunately, when the new terrain data base was installed during the pretraining for D/2/66 AR, just the opposite effect occurred. Targets engaged while aiming at the center of visible mass at distant ranges were usually hit, but targets at close range, 1200 meters or less, were often not hit. Since most SIMNET target engagements were at less than 2000 meters, the technicians reinstalled the old terrain data base and realigned the gun and fire control system more frequently. Therefore, inaccuracy in optimal point of aim for distant targets was present during all CAT training in SIMNET.

A second SIMNET gunnery problem reported by both TCs and GRs was the absence of reticle displacement after tracking and lasing, either when engaging moving targets, or when engaging stationary targets on the move. The reticle movement occurs in the M1 tank as the turret is rotated automatically to introduce lead angle while the sight is counterrotated to compensate for that lead angle and maintain the GR's sight picture. The tank GR is then required to relay on target, steadily track for 2-3 seconds, and fire. In SIMNET, they simply layed, lased, and fired, thereby speeding up their engagements. They did not have to (a) track the target for 3 seconds before lasing, (b) relay on the target center of mass after lasing, or (c) steadily track for 2-3 seconds before firing. As described in the Operators Manual for the M1 tank (TM 9-2350-255-10-1), the ballistic computer receives target rate information from control handle motion, calculates the lead offset, and

positions the gun and sight reticle. When the power control handles are centered or the palm switches released, the computer automatically sets the lead to zero.

A related gunnery problem in SIMNET was reported by the CO of D/4/8. During the unit's live-fire practice battle runs on Range 117 at Grafenwoehr, he noticed that most stationary target misses indicated azimuth errors, i.e., rounds impacting at the correct target range, but to the left or right. This phenomenon was regarded as unusual, since most misses with stationary targets are associated with elevation errors, i.e., rounds impacting short or passing over to impact beyond the target. In determining the possible cause for azimuth errors, the CO learned that in SIMNET the TCs and GRs could rapidly traverse to a stationary target or go from target to target and obtain hits without dumping the automatic lead input.

The TCs and GRs were questioned about possible negative effects of SIMNET training on their live-fire gunnery performance. They were convinced that any bad gunnery habits picked up during SIMNET training would be offset by the concurrent training they received on the M1 Unit Conduct of Fire Trainer (UCOFT) and in live-fire gunnery training during the CAT pre-competition training period. However, from the report of the D/4/8 CO, the SIMNET training evidently did interfere with some fine points in the engagement skills of some crews. From observation, only the CO from D/4/8 became aware of the problem and dedicated specific training to counteract any effects on gunnery skills from SIMNET training. The CO of this unit directed the TCs and GRs to install the Eye-Safe Laser Rangefinder (ESLR) devices on their tanks, and to dry-fire practice the correct gunnery procedure i.e., lay, lase, dump, and fire. As indicated in the M1 Tank Combat Tables (FM 17-12-1), the lead solution "appears to be a virtually continuous correction." However, the technique of lasing to the target, followed quickly by a shot without dumping lead, seems to give a greater probability of obtaining a target miss to the left or right.

Several additional differences in the way tank gunnery was performed in SIMNET, as opposed to procedures performed on a live-fire range set up for CAT competition, were reported by the tank crews. These included (a) operating closed-hatch instead of open-hatch, (b) traversing the cupola to see and control tank platoon alignment rather than simply looking left or right, (c) acquiring targets through the unity vision blocks versus looking through binoculars, (d) looking for a puff of smoke at the target to determine target hit rather than a small hole in the target panel, and (e) using the Gunner's Primary Sight (GPS) to engage black target panels instead of the tank's Thermal Imaging System (TIS) and heated black target panels. No serious impact of these differences was anticipated or later observed in crew or platoon gunnery performance. Furthermore, they did not seem to impede the training of platoon fire distribution and coordination during the simulated CAT exercise in SIMNET.

SIMNET Driving

During the initial SIMNET training periods, most of the CAT unit tank drivers experienced problems in performing basic M1 driving skills (steering, accelerating, braking) required in the CAT exercise. For some drivers, one or more of these problems persisted and were observed occasionally during their final days of SIMNET training. In steering the tank, drivers sometimes lost orientation and were observed turning in the wrong direction and oversteering to get into a column formation for movement to the competition range. During this movement, tank drivers often accelerated too fast or too slow to maintain the required interval from the tank in front of them. Later, when it became necessary to position their tank in its assigned firing lane, the drivers often moved into the wrong lane or drove beyond the stop point. In subsequent driving maneuvers to occupy the positions, they frequently failed to pivot steer in the proper direction or backed-up too fast, often throwing a (simulated) track in the process. After they finally moved into firing position at Bound One and were directed to move to Bound Two, the tank drivers often failed to stay on line with each other. The difficulty in maintaining alignment was repeatedly observed during the movement phases of tank platoon battle runs. On numerous occasions, company controllers were observed telling the tank drivers to speed up or slow down during a battle run movement.

Reports provided by tank drivers during the AAR sessions indicated that some of these problems were attributable to the SIMNET driving system, rather than poor driver performance. Occasionally, and despite their efforts to maintain a proper speed in SIMNET, the acceleration system seemingly did not respond accordingly. This apparent lack of system responsiveness was also reported when braking or steering the tank. The source of such difficulties was not identified during the period of observed SIMNET training. When trying to keep on line during tank movement, the SIMNET system did not allow the driver to see the tanks located on their flanks. Instead, they had to rely on driving commands from their TCs. In an M1 tank, an experienced driver does not require such constant assistance. The driver can move his seat and lean forward to look out the left or right vision block to see tanks located on his flanks.

Effects on CAT Performance

Amount of SIMNET Training. The SIMNET system was available to each of the U.S. companies for 16-17 days. The platoons in two of the companies, D/4/8 CAV and A/3/64 AR used SIMNET on 12-15 of the available days, while the platoons in D/2/66 AR used it on fewer (8-9) days. However, totals of 151 and 160 platoon exercises were recorded on SIMNET for D/4/8 and D/2/66 respectively. Of these 146 and 131, respectively, were complete battle runs. The remainder we have termed "partial runs", in the sense that (a) they were aborted before completion for various reasons, (b) they were performed under-strength with 3-tank or 2-tank platoons, or (c) they were done with all targets up and exposed, thus changing the target acquisition conditions present

in normal battle runs. The third company, A/3/64 completed only 100 battle run exercises, with no partial runs. Training statistics for individual tank platoons are presented in greater detail in Appendix E.

The companies also spent some time in free-play exercises in SIMNET that were not recorded. A/3/64 was observed to use a substantial portion of the time available in the free-play mode. This may partly account for the fact that the platoons in this unit completed fewer battle runs. The time spent in free-play by A/3/64 may have reflected higher confidence in the unit's readiness for competition relative to other units, making the leaders more willing to accede to demands for free-play time. Personnel in this unit expressed greater confidence in their readiness than other units. However, free-play was usually conducted at the end of training periods when the company commander felt that they had accomplished their intended training for that session, or that little benefit would be derived from further practice under conditions of fatigue and flagging motivation. The maximum continuous training period that could be used effectively appeared to be 2-3 hours, combining 2-4 exercises and AARs.

The time scheduled for SIMNET training bore little relationship to the number of battle run exercises completed. About 215 hours were scheduled by D/4/8 for SIMNET training, whereas only about 90 hours were scheduled by D/2/66, although both units completed similar number of exercises. However, a substantial portion of the additional hours scheduled by D/4/8 were consumed by this unit's sister Canadian unit. The Canadian unit completed 34 additional battle runs during the time periods scheduled by D/4/8. The scheduled time for A/3/64 was between the other companies, with about 165 hours available in SIMNET.

The number of SIMNET battle runs and partial runs for each platoon are shown in Figure 7. It is interesting to note that the top-performing platoon (1/D/4/8) also completed more battle runs than any other platoon. It is also apparent that all platoons in D/2/66 had more partial runs than the platoons in other companies. The partial runs may have detracted from the potential training benefits of SIMNET practice in this company.

There is some tendency for the number of completed battle runs to be positively related to CAT scores, as shown in Figure 8. It cannot be emphasized too strongly that the linear relationship indicated in Figure 8 depends almost entirely on the contrast between 1/D/4/8 and the remaining platoons; if this one extreme platoon were removed, no relationships would be evident. Statistically, the correlation coefficient ($r=0.53$) between scores and number of battle run exercises is not significant. With $df=7$ and $p=.05$, a significant correlation must be $r=0.67$ or larger. In addition, if the partial runs are included in the number of exercises, the relationship is reduced rather than strengthened.

Given the large number of important factors that differ among the CAT platoons and the restricted variation in performance among these highly trained units, a simple relationship between amount of SIMNET training and CAT scores should not be expected. The fact that 1/A/3/64 also obtained a high CAT score despite much less SIMNET training is simply a strong reminder

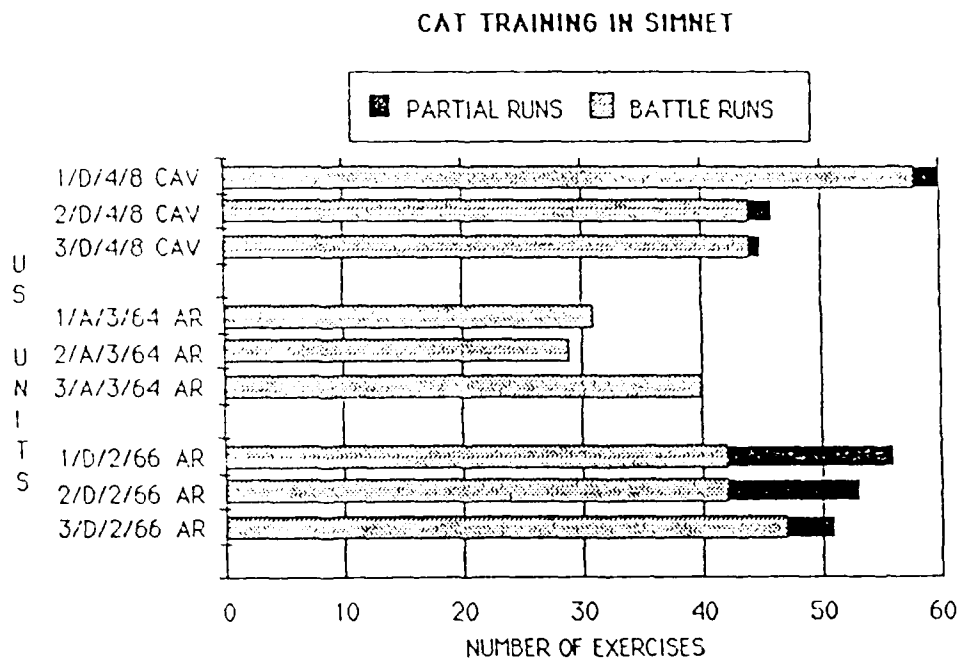


Figure 7. Number of complete battle runs and other partial runs conducted in SIMNET by each platoon.

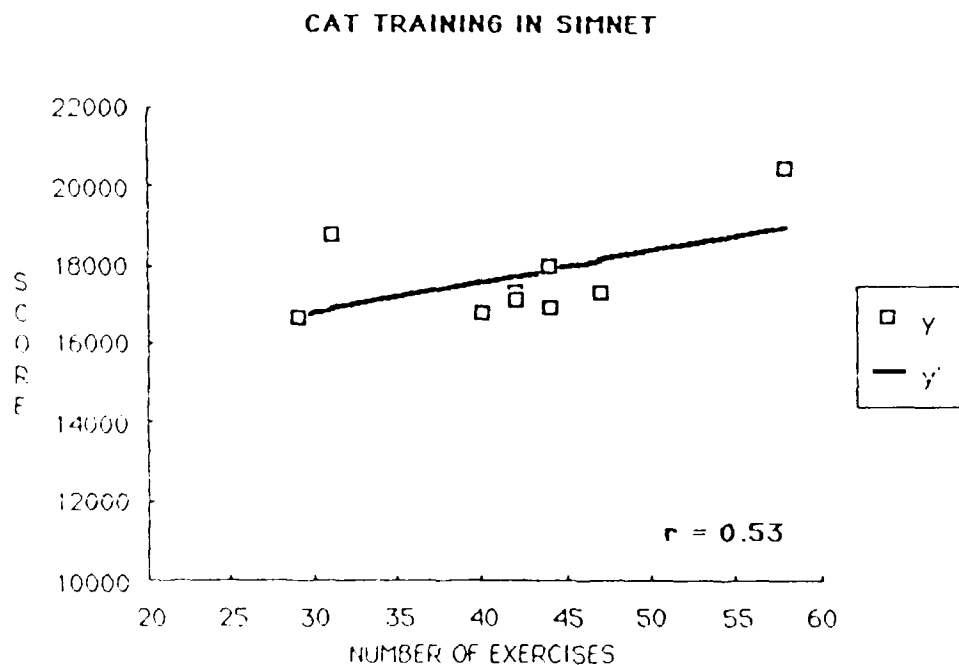


Figure 8. Relationship between CAT scores and the number of battle runs completed in SIMNET by U.S. platoons.

that there is "more than one way to skin a CAT." Convincing quantitative evidence of the benefits of SIMNET for platoon fire distribution must await better controlled comparisons.

Other Training

The U.S. CAT companies scheduled a wide variety of other training before, concurrent with, and after SIMNET training. From the information available, D/4/8 appeared to confine training almost exclusively to situations that were set up to directly simulate CAT battle runs, whether they involved 7.62 or 50 caliber ammunition being fired on subcaliber ranges, UCOFT, SIMNET or practice battle runs with MILES or the 105mm main gun. Platoon training was emphasized, with very little individual or crew training scheduled in preparing for CAT. Crew training in the UCOFT was the main exception to the emphasis on platoons. The complexity of the schedule was minimized. Usually one kind of training was scheduled for several days, and then some other kind of training was scheduled. This unit scheduled 162.5 hours of UCOFT training from February-June 1987. The UCOFT disc representing the CAT range was available from March onward.

In contrast, D/2/66 tended to emphasize subordinate crew and individual training objectives in addition to platoon-level exercises. Seven specific crew training objectives were defined, practiced, and monitored by retesting throughout the CAT preparation period, along with six platoon objectives or types of exercises. This led to a very complex training schedule and management problems evidenced by frequent schedule changes. Continued emphasis on subordinate skills may have tended to interfere with the consolidation of interactive skills at the platoon level. This unit scheduled 146 hours of UCOFT practice from February-May 1987, and had 144 additional hours in the preceding period of October-December 1986. However, no UCOFT training was scheduled in the seven weeks immediately before the CAT competition according to the records provided by the unit. The CAT range disc for the UCOFT was available to this unit from November 1986 onward.

The third U.S. CAT company, A/3/64 AR, appeared to take a training approach between those of the other units. Some individual training was done, but was mostly concentrated in the early months prior to selection of the unit for CAT. The training schedules were simpler than D/2/66, but more complicated than D/4/8. There was no indication of changes in the schedules. Most types of training were scheduled intensively for 1-2 weeks but not scheduled again for 1-2 months, or in some cases, never repeated. After December 1986, training was focused on the UCOFT and other collective training events. This unit scheduled 304.5 hours of UCOFT practice from February-April 1987, and had 176 additional hours in the period from August-November 1986. It is uncertain whether UCOFT training was scheduled in May and June 1987, since training schedules are not available for the weeks following the second week in May. Information on the availability of the CAT disc for the UCOFT also was not obtained for this unit.

Estimated hours for various training exercises used in preparation for CAT are presented in Appendix F. It should be noted that the time estimates are, in many cases, incomplete and/or unreliable. No information on training schedules before January 1987 was obtained from 2/66 AR. No training schedules were available from 3/64 AR for time spent at live fire ranges. Range time was estimated from times on score sheets, but other concurrent training may have been conducted. All units sometimes scheduled open-ended training sessions ("to Completion"), and such sessions were set most often for the UCOFT. In these instances, times were estimated from the "typical" lengths of sessions for the particular device or kind of exercise, based on the authors' past experience. The time estimates at their best provide no more than rough relative indications of how much, and when various types of training were conducted.

DISCUSSION

The purpose of this research was to collect and examine evidence concerning the training effectiveness of SIMNET in preparing U.S. Army Armor units for the 1987 Canadian Army Trophy (CAT) competition. Under the conditions prevailing in this research, however, few firm unqualified inferences can be drawn from the information obtained. The CAT performance of each U.S. platoon was the end result of a unique combination of multiple factors, and no means is available to separate the influence of individual factors on the differences observed among the platoons. Figure 9 shows graphically the multiple sources of influence that can possibly affect CAT performance, and the difficulty in distinguishing the impact of any one causal factor.

Furthermore, the contribution of SIMNET training to the overall level of CAT performance cannot be estimated quantitatively or tested statistically since the research was not designed for this purpose. In general, such research requires a control group of platoons with similar tank crew personnel, training in the same way as the CAT platoons, but omitting the SIMNET training. The control platoons also would have to complete CAT battle runs under the same conditions as the CAT units. Lacking such a control group it is impossible to determine with certainty whether SIMNET training benefited, reduced, or had no effect on the performance of the U.S. platoons in the CAT competition.

Despite these limitations, the observations and other training information provide indications of the effects of SIMNET training, and suggest the importance of some factors in determining these effects. The research findings provide important bases for hypotheses to be followed up in later research on SIMNET training. Keeping the above qualifications in mind, the research addressed the following questions.

1. What possible contributions did SIMNET training make in the performance of U.S. Army Armor units participating in the 1987 CAT competition?
2. What shortcomings in the SIMNET simulation system may have interfered with effective CAT training?

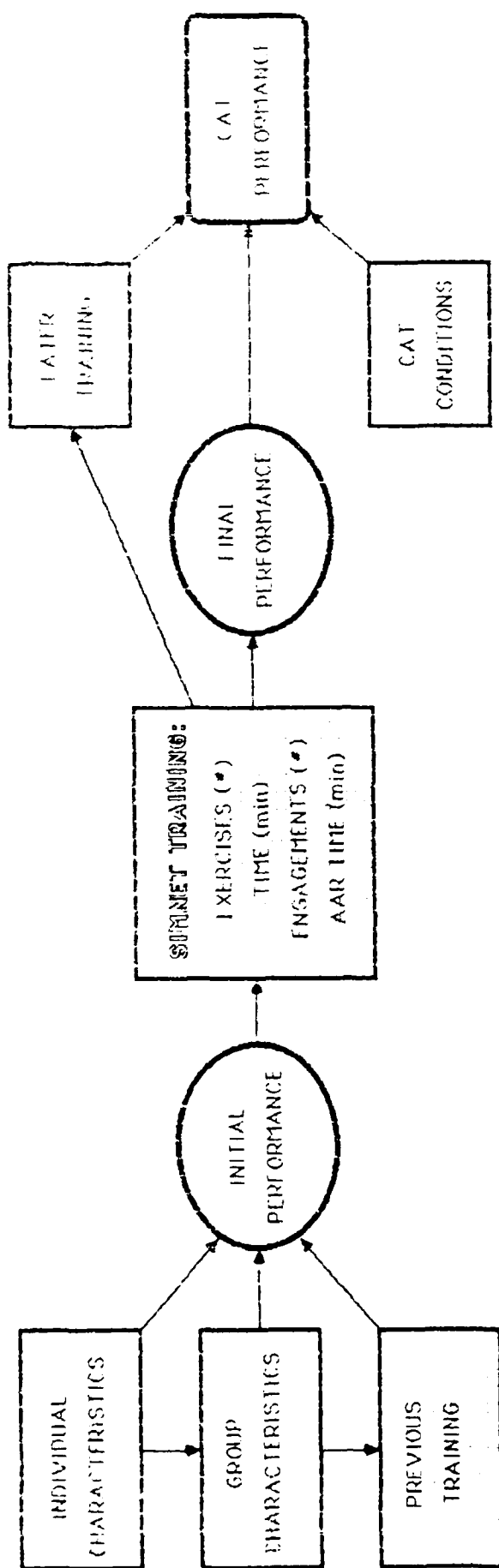


Figure 9. Multiple sources of influence that may affect CAT performance.

3. What training methods or techniques employed by the CAT units with SIMNET seemed particularly appropriate or effective?

4. What factors other than SIMNET training may have affected CAT performance independently or interactively with SIMNET?

SIMNET Contributions to CAT 87

Based on direct observation of SIMNET training, and subsequent examination of available data on tank platoon performance in CAT, it appears that SIMNET training may have made two types of contributions to the performance of U.S. armor units during the 1987 CAT competition. First, the opportunity to conduct CAT competition type battle runs in SIMNET may have made a major contribution by helping the tank companies and platoons develop and improve their fire distribution plans. Unit leaders confirmed and reassigned sectors of fire for individual tank crews to include the type of fire, frontal or cross, needed to engage targets presented at each bound. They also determined where and how the platoon would conduct tank section fire during a platoon battle run. The utilization of exercise replay on the PVD for AAR made discovery and correction of weaknesses in their fire distribution plans more likely than other types of training that do not have a replay and review capability.

Second, SIMNET training also seemed to help platoon leaders and platoon sergeants develop the command, control, and communication (C³) skills required to effectively execute their fire distribution plans during battle runs. Noticeable improvements were observed from initial to final SIMNET performance in obtaining (a) accurate tank crew target and ammunition counts, (b) timely and orderly tank crew reports, (c) clear and uninterrupted tank radio net transmissions, (d) calls for help when presented multiple target arrays, and (e) proper tank alignment during platoon movement.

One additional contribution of SIMNET training may have been to familiarize the tank crews with the layout of the CAT competition range and the likely location of targets that could be presented to them during a platoon battle run. As remarked by several CAT participants, the competition range looked a lot like SIMNET's. However, it is not known whether the SIMNET CAT range was more or less similar than other exercises (terrain board, UCFT subcaliber, main-gun ranges) that were also set up to represent the CAT range.

SIMNET Shortcomings

Simulation of the M1 tank's fire control system prevented fully effective CAT training and was the most apparent shortcoming in SIMNET. Unlike the M1, the SIMNET fire control system does not displace the sight reticle after lasing on a moving target or after lasing on a stationary target from a moving tank. As a result, GRs in SIMNET did not practice relaying the sight reticle on target center of visible mass before firing. Also, the SIMNET fire control system does not account for automatic lead inputs obtained when

rapidly traversing to a stationary target or when going from target to target. As a result, there was some evidence that GRs in SIMNET did not practice dumping the lead after lasing on a target by either centering the control handles or momentarily releasing the palm switches before firing. The lead system in SIMNET also does not require the GR to steadily track moving targets for 2-3 seconds after lasing and before firing. In SIMNET, GRs can immediately fire after they lased on a target.

Another shortcoming in the SIMNET fire control simulation system is that it does not provide the correct ballistic solution for hitting distant targets. When such targets were engaged, the rounds consistently fell short. To obtain a hit, GRs had to aim high on the targets rather than center of target visible mass.

Since GRs were being trained to perform tank gunnery procedures differently in SIMNET than they would on an M1 tank, unit leaders could not use the computer printouts to provide accurate feedback on either individual or platoon gunnery performance. They also voiced their concerns about possible negative training effects. However, only the CO of D/4/8 scheduled dry-fire ESLR training to ensure that his GRs corrected for automatic lead inputs. All other unit leaders relied on UCFT and live-fire training to offset any possible effect.

Additional shortcomings in the SIMNET system were found in the simulation of M1 driving. Drivers could not always obtain the same apparent responsiveness in accelerating, braking or steering as they had come to expect on the M1 tank. The resulting errors in speed control and turning, therefore, could not be attributed to a lack of driver proficiency. Drivers also were observed to have initial difficulty in maintaining proper speeds and alignments in platoon formations during the battle runs in SIMNET. The drivers were required to rely more heavily than normal on TC driving commands and guidance, in part because they were unable to adjust their field of view to check the positions of other tanks.

The shortcomings of SIMNET in both GR and driver positions prevented these crewmen from fully integrating well-learned individual skills with the additional requirements of platoon fire control and distribution. This may have prevented the demonstration of more dramatic benefits of SIMNET training for a large proportion of the CAT platoons.

SIMNET Training Methods

The training method employed by CAT unit leaders that seemed particularly appropriate and effective during SIMNET training was demonstrated in the controller's use of the PVD playback capabilities during the AAR sessions. Specifically, the unit controller(s) replayed the platoon's completed battle run until the first set of targets appeared on the PVD. He then stopped the PVD playback and questioned the tank crews as to (a) the number assigned to each of the targets displayed, (b) the tank crew responsible for engaging each target, and (c) the order in which multiple targets presented in a tank's firing sector are engaged. Once this was completed, the PVD playback

was restarted to let the tank crews see what actually happened during the engagement. At the same time, the audio tape-recorder was started to let the tank crews hear what they were reporting over the radio net. When the engagement was completed, both the PVD and tape-recorder were stopped. Tank crews that correctly engaged and reported targets according to the unit's fire distribution plan were complimented by the unit leaders. Crews that did not do so were questioned on the errors and told what to do during such engagements in future SIMNET battle runs. This approach was then repeated for the remaining battle run engagements.

No effective means of intervening or providing external feedback during the conduct of platoon battle runs were observed. However, attempts to intervene during the battle runs would not usually be appropriate because of the fast paced, brief nature of these exercises.

Factors Affecting CAT Outcomes

Comments from the CAT unit leaders indicated that conducting live-fire platoon battle runs using both sub-caliber and main gun ammunition was a major factor affecting CAT outcomes. These live-fire exercises enabled them to assess individual tank crew gunnery strengths and weaknesses, as well as deficiencies in platoon fire distribution and provide the remedial training needed to correct them. It also allowed them to identify and correct tank equipment malfunctions. Pre-competition shoot-offs with other nations competing for the CAT trophy were reported particularly beneficial. These international matches, complete with national flag waving, VIP spectators and intense competitors, not only allowed the units to practice the CAT competition rules and procedures, but they helped the individual platoon leader and crew members overcome the stress and anxieties that may affect their performance.

Unit leaders indicated that M1 UCOFT training was another major factor affecting CAT outcomes. Prior to CAT training, the weapons system simulator was used extensively to sustain and enhance the gunnery proficiency of tank crews. In fact, platoon leaders commented that all their TC-GR pairs were UCOFT certified prior to CAT and that being certified was a major factor in their selection for the competition. During CAT training, company commanders considered UCOFT training essential in eliminating any possible negative training that may have resulted from tank gunnery practice in SIMNET, and in bolstering the confidence of TCs-GRs frustrated by their inability to hit targets during SIMNET battle runs. They also commented that the CAT UCOFT disc graphics and training matrix provided by the 7ATC CAT Liaison team was very helpful in that it allowed their tank crews to practice both precision and degraded mode gunnery on the CAT competition range. However, for two of these units, D/2/66 and A/3/64, it is unclear whether they had an opportunity to use UCOFT between the last SIMNET training and the competition.

An additional factor that CAT unit leaders reported contributing to CAT competition outcomes was the Range 301 terrain boards provided to them by the 7th ATC CAT Liaison Team. These terrain boards allowed them to (a) familiarize the tank crews with Range 301 configuration and likely target locations, (b) memorize target numbers, and (c) develop their fire control distribution plans by conducting walk-through platoon battle runs.

We have attempted to summarize in Table 4 the possible influences of the multiple factors on CAT results mentioned in previous sections of this paper. In this table, the three U.S. companies are ranked from 1 to 3 corresponding to the order in which they may have been favorably affected by the factor. For example, A/3/64 had the most personnel with prior experience in CAT, since this company had also competed in CAT '85. This unit was assigned rank 1. The other two companies had not previously competed in CAT and had few, if any, personnel with such prior experience. These units were assigned the midpoint (tied ranks) of ranks 2 and 3.

Table 4

Rank Order of Units on Possible Factors Affecting CAT Outcomes

FACTOR	UNIT		
	D/4/8 CAV	A/3/64 AR	D/2/66 AR
Prior CAT Experience	2.5	1	2.5
Specificity of Fire Plan	2	1	3
Target Memorization Technique	1	2	3
Amount of SIMNET Training	1	3	2
Quality of SIMNET Instruction	1	2.5	2.5
Quality of SIMNET AARs	1	3	2
Commander Involvement in SIMNET	1	3	2
SIMNET Equipment Reliability	1	2	3
Absence of Visitors	1.5	1.5	3
Fire Plan Modification	1	3	2
Post-SIMNET Skill Repair	1	2.5	2.5
Emphasis on Platoon Training	1	2	3
Total UCFT Training	3	1	2
UCFT Matrix Level	2	2	2
UCFT Training Near CAT	1	2	3
Simplicity of Scheduling	1	2	3
Months of CAT Preparation	3	1	2
SOP/Terrain Board	3	2	1
Subcaliber Practice	2	1	3
Livefire Practice	1.5	1.5	2

It is interesting to note that D/4/8 CAV had high ranks on several factors relating to use of SIMNET in training. The relatively high CAT perform-

ance in this company in part may reflect the fact that they used SIMNET under more favorable conditions and used it to greater advantage than other units. The factor of commander involvement in SIMNET training may have contributed to their high standing on several of the other factors associated with SIMNET training. As is true of many training devices, the benefits to be derived from SIMNET training probably depend strongly on how that opportunity for training is used, as much or more as the resemblance between the device and operational environments.

Among the other factors listed in Table 4, the target memorization technique (numbering system), modifications to the fire plan, emphasis on platoon training, simplicity of scheduling, and live-fire practice are also associated with high performance by D/4/8 CAV. All of the remaining factors show inconsistent relationships with CAT performance. Overall, D/4/8 ranked 1 or 1.5 on the largest number of factors, corresponding to its higher level of performance.

CONCLUSIONS

The major findings of this research are summarized below:

1. Platoon battle run training in SIMNET appeared to enhance performance of U.S. Army tank units in two ways:
 - a. SIMNET exercise replays in after-action reviews (AARs) permitted improvement of unit SOPs and fire distribution plans for CAT battle runs.
 - b. SIMNET training developed specific leader command and control skills and platoon teamwork important for effective performance in CAT battle runs.
2. Particular SIMNET deficiencies in the representation of M1 control operations impeded full integration of tank crewmen's individual skills into practice of platoon gunnery:
 - a. Inaccuracies in point-of-aim and simulation of automatic lead prevented execution of completely proper gunnery procedures, interfering with some detailed elements of skills previously learned.
 - b. Drivers had difficulty in performing basic fine control skills learned on the tank, and in maneuvering precisely within platoon formations.
3. Unit leaders and controllers require training or experience with the Plan-View Display (PVD) and exercise replay to make most effective use of these SIMNET capabilities in AARs. To be useful, computer printouts of the performance data need to be easily related to the objectives of training.
4. The U.S. tank company that performed best in CAT 87 appeared to be favored by multiple factors in their training and preparation for CAT, and

many of these favorable factors were associated directly or indirectly with effective use of the SIMNET training opportunity. Intensive crew and platoon gunnery practice by various methods (UCOFT, Sub-caliber, Main Gun) immediately prior to the CAT competition also characterized this company.

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APPENDIX A

1987 CANADIAN ARMY TROPHY (CAT) COMPETITION RULES AND CONDITIONS

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CANADIAN ARMY TROPHY (CAT) COMPETITION

RULES AND CONDITIONS

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CANADIAN ARMY TROPHY (CAT) COMPETITION15-19 JUNE 1987RULES AND CONDITIONSA. GENERAL REMARKS AND POLICY

1. Origin. The Canadian Army Trophy was initiated in 1963 at the suggestion of Canada. At that time Canada donated a replica of the Centurion Tank known as the Canadian Army Trophy for NATO Tank Gunnery. This Trophy was to be competed for by teams of the member countries stationed in the Central Region.

2. Aims. The aims of the competition are:

- a. To improve the overall standard of tank gunnery within participating forces; and
- b. To enable participating teams to meet in a spirit of true comradeship and fraternity.

3. Development of the Competition.

- a. Since 1963, the competition has evolved to better achieve its purpose. Originally, single tanks fired from fixed points at known ranges. After the 1968 and again after the 1975 competitions, changes were made in the conduct of the competition to reflect combat conditions as much as possible.
- b. The competition now requires fire and movement over a course designed to test the skills of the competing tank units under more realistic combat conditions. Negotiation of the course is termed a "Battle Run". Each battle run consists of firing from static positions and firing while on the move, engaging both static and moving targets.
- c. From 1963 through 1968, the competition was held annually. Since that time the competition has been held biennially during odd numbered years.
- d. At the conclusion of the 1981 competition CINCENT, supported by the participating nations, proposed that changes be made to the competition to provide a better means of achieving the aims and to reflect the true nature of the event; namely, a competition among the land forces of the Central Region. Accordingly, the

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1983 Canadian Army Trophy was the first competition between tank platoons from the Northern Army Group and the Central Army Group. The Canadian Army Trophy for NATO Tank Gunnery is presented to the winning Army Group Team.

e. Following the success of the new concept, it was agreed by CINCENT and the Committee of Control to end national hosting of the competition in 1985 and have the Army Group Headquarters assume that responsibility for alternating competitions.

f. The record of past competitions is at Annex A.

4. The 1987 Competition. At CAT 85 the Commander, Central Army Group, agreed to host the next CAT in June 1987.

B. PLANNING AND RESPONSIBILITIES

5. AFCENT Sponsorship.

- a. CINCENT sponsors the competition. His representative will be the Assistant Chief of Staff, Policy Division, HQ AFCENT.
- b. The AFCENT Project Officer will be provided by the Exercise Branch, Operations Division, HQ AFCENT.
- c. CINCENT issues the Rules and Conditions for the competition and additional guidelines as deemed necessary.

6. Committee of Control.

- a. The Canadian Army Trophy Competition Committee of Control (CATCC), chaired by HQ AFCENT, plans and supervises the competition. It convenes at times and places designated by the Chairman and during the competition.
- b. The Committee consists of the following permanent members:
 - (1) Chairman, who is ACOS POLICY, HQ AFCENT;
 - (2) Secretary, who is the HQ AFCENT Project Officer;
 - (3) One representative of the Canadian Government;
 - (4) One representative of HQ CENTAG;
 - (5) One representative of HQ NORTHAG;

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- (6) One representative from each of the nations contributing armoured forces to the Central Region (BE, CA, GE, NL, UK and US);
- (7) The Chief Judge, when appointed.
- c. The list of current members of the Committee is at Annex B.
- d. The presence of all CATCC members or their authorized representatives is required to hold a CATCC meeting.
- e. The voting members of the CATCC are:
 - (1) Chairman;
 - (2) Canadian Government Representative;
 - (3) CENTAG Representative;
 - (4) NORTHAG Representative; and
 - (5) Representatives of each nation contributing armoured forces to the Central Region.
- f. At least 70% of voting members must agree for a CATCC decision to be reached.
- g. All members of the CATCC, except the Chairman, should be armoured officers.
- h. Members of CATCC must not be tasked with additional duties during the competition. They may be permanently or temporarily replaced by their parent HQ after notification to HQ AFCEM.
- i. The Chairman may request the assistance and attendance of Technical Advisors or Range Advisors at CATCC meetings. They do not take part in any voting.
- j. The Committee is responsible for:
 - (1) Preparing the Rules and Conditions for the competition;
 - (2) Deciding on proposals and suggestions made by participating forces and submitted to members of the CATCC;
 - (3) Supervising the conduct of the competition IAW the Rules and Conditions;

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- (4) Taking action on protests submitted by the Chief Judge during the competition; and
 - (5) Promulgating the official results of the competition.
- k. Duties of the Members of the Committee or their representatives are:
- (1) Attend the meetings of the Committee;
 - (2) Act as liaison officers between HQ AFCEM, CATCC, the Host Army Group and their own nations or HQs for all matters concerned with the competition;
 - (3) Prepare a preliminary Post Competition Report based on the comments and observations of the Committee members. A meeting will be held on the last day of the competition to discuss the content of the report. As a minimum it should include:
 - (a) views on participation in the next competition,
 - (b) proposals, comments and suggestions regarding the rules of the competition and its conduct as may be deemed necessary, and
 - (c) details of training procedures developed and lessons learned as a result of participation in the competition.
 - (4) The final Post Competition Report will be prepared by the CATCC Secretary based on submissions of Committee members. Committee members must submit their comments no later than 60 days following the competition and the final report will be prepared after an additional 30 days. Subject areas must include, as a minimum, those items listed in paragraph 6k(3).
- l. The Canadian National Defence Headquarters has appointed the Director of Armour as the representative of the Canadian Government. His additional duties are to:
- (1) Ensure that the Canadian government is informed of changes to the basic rules that may be proposed by the Committee;

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- (2) Ensure that the trophy is maintained by the winning Army Group in accordance with the procedures outlined at Annex C; and
- (3) Inform the Committee when required of the name of the Senior Canadian Officer who will attend the competition.

7. Host Army Group.

- a. The Host Army Group conducts the competition according to the Rules and Conditions and CINCENT's guidance.
- b. The Host Army Group, in liaison with the AFCENT Project Officer and other CATCC members as appropriate, coordinates all the arrangements for the competition, including the reception of the teams and the Opening and Awards Ceremonies.
- c. The Host Army Group nominates the Chief Judge and Host Army Group Project Officer.
- d. The Host Army Group will:
 - (1) Hold an administrative meeting with the AFCENT Project Officer, other members of the CATCC as appropriate and representatives from participating formations at least one year prior to the competition.
 - (2) Hold a final administrative meeting at least four months prior to the competition to produce the final Administrative Order to be issued at least three months prior to the competition week.
- e. During the competition the Host Army Group is responsible for posting the results on the appropriate scoreboard, after they have been officially approved and released by the Committee of Control.
- f. The Host Army Group is to make all arrangements regarding the lodging of the Army Group teams, but is not to be concerned with the mode of travel, which is the responsibility of the parent organization.
- g. For further details regarding accommodation and messing see Section H.
- h. The Host Army Group for the succeeding competition should appoint the Chief Judge prior to the current

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year competition. Early identification of the Chief Judge will enable him to observe the competition and gain valuable experience and background for planning the next competition. However, if early selection is not possible candidates for the position should be restricted to individuals with, at minimum, prior experience as a national judge.

- i. The Chief Judge may designate an officer of his choosing to serve as "assistant to the Chief Judge".

8. Languages.

- a. English will be used for all meetings and correspondence of the Committee of Control, and will be the language of the competition.
- b. The Rules and Conditions will be published in English and French by HQ AFCENT. Subsequent translation into other languages will be the responsibility of the participating formations. In case of doubt, the English text will take precedence.
- c. During the competition, national languages are authorized for the orders given to crew members, within the competing platoons.

C. PRIZES AND AWARDS

9. Canadian Army Trophy. The Canadian Army Trophy is a model of a Centurion tank in silver, mounted on a black stand. It remains the property of Canada, which offers it for the competition. It is presented by CINCENT to the winning Army Group which retains it until the time fixed for the next competition. The winning Army Group will be responsible for the safe custody of the Canadian Army Trophy in accordance with the instructions at Annex C.

10. Army Group Trophies. COMCENTAG and COMNORTHAG will present their rotating commanders' trophies to the highest scoring platoon in their respective Army Groups.

11. Awards. The following awards are retained permanently:

- a. Replica models of a Centurion tank, donated by HQ AFCENT, presented by the Senior Canadian Representative to the Unit Team Leaders.
- b. The COMNORTHAG awards presented to the three high scoring NORTHAG platoons.

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- c. The COMCENTAG awards presented to the three high scoring CENTAG platoons.
- d. A certificate signed by CINCENT and the Chairman of the Committee of Control for all official participants in the competition, presented by the senior Commanders of participating forces after the Awards Ceremony.
- e. The Canadian Army Trophy, Centurion tank replicas, COMNORTHAG awards, COMCENTAG awards, and certificates will be made available to the Host Army Group Project Officer the week prior to the start of the competition.

D. PARTICIPATION

12. General.

- a. The competition will be held at a firing range, to be determined, in the Central Region.
- b. Canadian Army Trophy (CAT) Competition will be a competition between tank platoons from NORTHAG and tank platoons from CENTAG. The winning Army Group will be determined by the aggregate score of the competing platoons comprising each Army Group Team.
- c. Other NATO nations and organizations outside of the Central Region may be invited to send observers to the competition as determined by CINCENT.

13. Team Composition.

a. NORTHAG

- (1) The NORTHAG Team Captain will be appointed by COMNORTHAG. He will be assisted by the commanders of the participating companies who will be called Unit Team Leaders.
- (2) Companies will be formed as follows:

I(BE) Corps	2 platoons
1(BR) Corps	3 platoons
I(GE) Corps	2 platoons
I(NL) Corps	2 platoons
2(US) AD (Fwd)	3 platoons
- (3) Total of 5 companies/12 platoons.
- (4) Each platoon will be organized with its organic number of tanks.

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b. CENTAG

(1) The CENTAG Team Captain will be appointed by COMCENTAG. He will be assisted by the commanders of the participating companies who will be called Unit Team Leaders.

(2) Companies will be formed as follows:

II (GE) Corps	2 platoons
III(GE) Corps	2 platoons
V (US) Corps	3 platoons
VII(US) Corps	3 platoons
4 CMBG	2 platoons

(3) Total of 5 companies/12 platoons.

(4) Each platoon will be organized with its organic number of tanks.

c. Duties of the Army Group Team Captains and Unit Team Leaders are outlined at Annex D.

14. Team Selection Criteria.

a. All regularly formed (organic) Corps/Separate Brigade tank companies are eligible for participation in the competition regardless of make or type of tank.

b. Each Army Group Corps will designate a minimum of one company from two different battalions, and each separate Brigade will designate a minimum of two companies to put into a pool.

c. The formation of special companies and/or alteration of national personnel assignment policies for the competition is prohibited.

d. Selection of the competing tank companies will be made on a random basis by HQ AFCEM from the pool.

e. Each Army Group is to provide HQ AFCEM with a list of the designated tank companies no later than 1 Jan 1987. HQ AFCEM will make a random selection of the tank companies to compete no later than 1 April 1987.

f. Tank commanders and gunners may not compete in successive CATs in the same tank duty position as the preceding CAT. Violation of this rule will cause the platoon to be disqualified. Exception: A Tank Commander

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who is promoted to Platoon Second-In-Command may participate.

- g. A complete company roster (by name, service number and position) will be submitted for each company in the pool. This roster must arrive at HQ AFCENT NLT 27 March 1987.

15. Competition Range Selection. The Host Army Group will advise HQ AFCENT of the name of the competition range NLT 1 January prior to the competition. This will allow the Chief Judge to commence his planning.

16. Pre-Competition Training Restrictions

- a. Main gun range time provided competing tank companies should be limited to the normal national yearly allocation.
- b. The competition range will be OUT OF BOUNDS to all companies in the pool that were designated on 1 January from that time until the competition. The competition range will be made available for specific safety orientation during the day prior to the start of the competition.
- c. Each Army Group team should be allocated two and one half days live firing on a range other than the competition range during the week prior to the competition.
- d. Total main armament ammunition expenditure for designated tank companies will not exceed 134 rounds per crew from 01 October 1986 to the competition.

17. Equipment

- a. Tanks are to conform to normal national standards and no special equipment is to be fitted for competition purposes.
- b. Tank companies selected for the competition are to use their own organic tanks.
- c. The use of integral range-finding equipment during the competition is optional.
- d. After a platoon moves to the zero range, maintenance and repairs to all equipment used by that competing tank platoon will be accomplished by those assets (personnel and facilities) normally available to that

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unit in combat. This excludes the use of personnel from National Reserve Forces. The use of technical advisors from civilian corporations and manufacturing concerns is prohibited. This provision will remain in effect until completion of the battle run.

18. Certification. Army Group Commanders are to certify, in writing, to CINCENT compliance with the above conditions two weeks prior to the competition.

19. Team Registration

- a. On the Friday prior to the competition, a team briefing will take place at which Army Group Teams will be represented by their Team Captains, and they will hand to the Chief Judge their team lists of personnel who will fire. The following will be shown:
 - (1) Name and initials
 - (2) Rank
 - (3) Serial/Service number
 - (4) Identification Card Number
 - (5) Crew position
 - (6) Date of posting to the battalion and company.
- b. Team lists will be signed personally by the Army Group Team Captain and the respective Unit Team Leader.
- c. Team members must have been on the posted strength of their assigned company as of 26 March 1987.
- d. Team members must be currently employed as commanders, gunners, loaders, and drivers, and must not be of a rank higher than the established rank in the TOE as of 26 March 1987. Those promoted after 26 March 1987 may remain in the same duty position and participate in the competition.
- e. From the time of the team briefing, no changes may be made to the nominated team lists except as indicated in paragraph 21. Thus, should a nominated crew member be unable to compete, only a nominated reserve may take his place.

20. Tank Registration. On the Friday prior to the competition, the registration numbers of participating tanks in each Army

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Group will be declared to the Chief Judge. Thereafter, no replacement tanks will be allowed except as indicated in paragraph 21.

21. Team Reserves

- a. Replacement personnel and equipment will come from within the national competing tank companies of each Army Group Team.
- b. If an original member of a competing platoon is certified by the Army Group Team Captain and the Unit Team Leader as being unable, for unavoidable reasons, to take part, then he may be replaced by an individual of the same rank and position from another competing platoon of the same tank company as specified in para 21.d. Under no circumstances will an individual compete as a member of a tank crew more than twice. Medical exemptions will be verified by a qualified medical authority (physician).
- c. The tanks from a company of an Army Group Team may be replaced by another tank from the same company, if required, at any time up to the moment they are called forward from the waiting area, as specified in para 21.d. Under no circumstances will a tank be used in more than two battle runs.
- d. The first platoon to fire from a tank company of an Army Group Team will provide the individual and tank replacements for the remaining platoon(s). The last platoon to fire from a tank company of an Army Group Team will provide individual and tank replacements for the first platoon to fire.

22. Spectators.

- a. Spectators are to be restricted to the allocated spectator area and are prohibited from contacting competitors once they have arrived in the waiting area. Range finders and communications equipment are not to be allowed in the spectator area. It is imperative that spectators comply with the foregoing as well as with any other applicable instructions. It is also essential that spectators are tightly controlled in the areas where the tanks are being moved.
- b. Team members may watch the competition from the spectator area.

23. Team Quarantine. A quarantine area for members of competing teams may be established by the Chief Judge if it is considered

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necessary in the interest of fairness or in order to maintain control over the competition.

E. DESCRIPTION AND CONDUCT

24. Firing Practice Concept.

- a. The competition will take the form of a fire and movement exercise by competing platoons using any form of tactical movement. Each platoon practice is called a Battle Run.
- b. A relay is defined as the completion of one Battle Run by one platoon from each competing company making-up each Army Group Team.
- c. The tanks in a platoon have common arcs of fire on each bound. Guns must be kept within their arcs throughout the battle run. Individual tank fire positions are marked on each bound.
- d. The Chief Judge, after the safety orientation briefing, will also brief the Army Group Teams on the firing practice concept.

25. Ammunition.

- a. Each tank is to stow 10 practice rounds (DS/T, TPDS, MZ, KE, CE, or "Lochkegel-leitwerk") for the main armament and a total of 250 rounds of MG ammunition. The combination of tracer and ball ammunition loaded may not be more than one tracer round for every three ball rounds (i.e., no more than 62 tracer rounds out of the 250 rounds of MG ammunition).
- b. In addition, each tank is to carry a reserve of four main armament rounds and 125 rounds of MG ammunition which may be used only with the judges authority (see para 43).

26. Targets.

- a. All the targets to be used will be of the same size and shape. An example is illustrated at Annex E. The targets will measure 230cm in width and 230cm in height, and be painted a dark color.
- b. Some type of visible hit indicator system will be used, if possible.

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- c. Teams will NOT be advised of the total number of targets for each Battle Run until the day prior to the competition.

(1) Main Armament.

- (a) The Chief Judge will plan his scenarios for a minimum of 18 or 24 targets and a maximum of 27 or 36 targets depending on the number of tanks in a platoon; however, the total number of targets will be the same for each similar sized platoon. The Chief Judge will advise Team Captains of the total number of targets the day prior to the competition.

- (b) The targets will be static or moving. The movers may be head-on, oblique or broad side.

(2) MG

- (a) The Chief Judge will plan his scenarios for two groups of 10 falling plates per firing lane. The Chief Judge will advise Team Captains of the total number of targets the day prior to the competition.

- (b) The falling plates engaged during the move between the first pair of bounds will not be engaged again during the move between the second pair of bounds.

- d. All targets may be engaged by one or more tanks within the platoon.

- e. Each main armament engagement will comprise from two to eight targets at various ranges. Main armament targets need not be visible to each tank within a platoon except on the last bound where all main armament targets are to be visible to each tank.

- f. There will be a minimum of twelve different target layouts and two spare layouts for reruns. Each layout must comprise as a minimum:

(1) Static engagements:

Five main armament engagements distributed during the battle run including;

- (a) two engagements with both static and moving targets, and

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(b) one engagement with six/eight targets depending on platoon size.

(2) Moving engagements:

Two main armament engagements must be while the vehicle is on the move against both moving and/or stationary targets.

- g. Examples of battle runs for a four tank platoon and for a three tank platoon, with both moving and static targets, are shown at Annex F.
- h. One tank platoon of each of the Army Group Teams will fire each one of the twelve target layouts so that each Army Group tank platoon has a different target layout.
- i. The main armament targets within each of the twelve target layouts may be substituted by other targets of the same range and general location at the discretion of the Chief Judge.
- j. All targets which have to be engaged within an engagement will be indicated by a single puff in front of the phase line. The puff will be fixed within 5 seconds of the complete target presentation being fully upright. This means, for example that there will be only one puff for as many as six/eight targets. MG targets will not be indicated. If during an engagement, additional puffs are accidentally initiated, these are to be disregarded.
 - (1) If the platoon has engaged targets and the puff fails, continue shooting. This is considered a valid engagement.
 - (2) If the platoon has not engaged targets and the puff fails the Chief Judge will announce on the radio "STOP, STOP, STOP". He will then restart the exercise.
- k. In the interest of fairness, information regarding the layout of the competition range may not be given to the competing teams. In selecting scenarios, the Chief Judge will draw them by lot on the evening of the preceding day at the earliest.
- l. Heating devices will be affixed to the targets. Additional heating devices will be deployed as decoys.

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27. Relay Order.

- a. Team Captains are responsible for determining the sequence in which their companies will compete, as well as the firing sequence of the platoons in each company. On the Friday prior to the competition, the Team Captains will inform the Chief Judge of the firing order for their Teams. The firing order for Army Group Teams should be such that the next platoon belongs to a different nation.
- b. Following is an example starting system:

	M	T	W	T	F	
	1C	3N	1C			
	1N	4C		4C		
SEQUENCE OF	2C	4N	2N		2N	N=NORTHAG
COMPANIES TO	2N	5C	2C	5N	2C	C=CENTAG
FIRE	3C	5N	3N	5C		
		1N	3C	1N		
			4N	1C		

28. Zeroing.

- a. A zeroing range will be made available to competing teams by the Host Army Group. Competing teams may zero their guns under national procedures on this range which will be available to each platoon for a maximum of 60 minutes. If the platoon has not completed their zeroing at the end of 60 minutes they will be ordered off the firing point by the Zeroing Range Officer.
- b. Only national zeroing targets will be erected on the zeroing range and no additional targets will be allowed.
- c. After zeroing, the platoon moves to a waiting area near the competition range.

29. Control Procedures.

- a. The Chief Judge will specify the exact times platoons are to arrive at the waiting area. As stated in para 23 the Chief Judge may establish a platoon quarantine in the waiting area. The competing platoon is responsible for obtaining escort vehicles with flashing lights for the front and rear of the platoon to assist in movement from unit lines to the zero range, then to the waiting area, and on completion of the battle run return to the unit lines.

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- b. After having reached the waiting area, radio communications will be established and ammunition storage will be controlled. The tank registration numbers and crews' identities will be checked by a multi-national Control Team as described in para 41.
- c. On the day prior to STARTEX, all competing tank crews will be briefed on the safety and control procedures (arcs of fire, lanes, bounds, etc) by a competition judge on behalf of the Chief Judge. The total number of targets to be exposed for each different sized platoon will also be announced.
- d. Except as stated in para 21, no member of a team may take part in more than one battle run.
- e. Except as stated in para 21, no tank may be used in more than one battle run.

30. Battle Run Procedures.

- a. Movement from the waiting area to the competition range will be executed on notice from a national competition judge on behalf of the Chief Judge. Escort vehicles with flashing lights will be provided by the control staff for the front and rear of the platoon to ensure safe and controlled movement from the waiting area to the battle run range.
- b. Radio communications between all tanks of the firing platoon and the Control Staff will be arranged by the Chief Judge.
- c. All commands to the firing platoon during a battle run are to be given by a national competition judge in the national language of the competing platoon.

31. Outline of the Competition.

- a. After control has been established in the waiting area (para 29), a national competition judge is to give the command "MOVE TO BOUND ..." by radio. Once the order to move has been acknowledged by the competing platoon, the movement from the waiting area to the competition range will be under the control of the control staff organization. Speed of movement based on safe driving conditions will be strictly adhered to.
- b. For safety reasons the move to first bound from the waiting area is to be carried out with weapons clear.

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After arrival at first bound, weapons are to be loaded on the command "CARRY OUT ACTION". A maximum of two minutes will be allowed to carry out action. When the platoon reports "READY" or when the two minutes has expired, the command "WATCH YOUR FRONT" will be given by a national competition judge.

- c. Main armament targets will be exposed for 40 seconds. This time will begin when each individual target is upright. After the command "WATCH YOUR FRONT", targets may be presented without further warning. A second group of targets may be presented at any time but the total number of targets exposed will never exceed six/eight. There is no restriction on the number of rounds which may be fired at any target. All targets in a target group will be lowered at the same time. When no more targets are to be presented from a bound, the order "YOUR FRONT IS CLEAR. YOU MAY MOVE TO BOUND..." will be given.
- d. Main armament targets and MG falling plate targets may be presented between each of the bounds. During a move, all targets must be engaged while maintaining movement. This includes target acquisition, laying, ranging and firing. If a tank halts for any reason between bounds and subsequently fires, a zero score will be given to the entire platoon for that particular engagement. If a machine gun target is engaged with main armament, no points for that MG falling plate area will be given. Each set of MG falling plate targets are to be engaged only during a single engagement. If an area is engaged twice, there will be no score allocated to the falling plates hit during this second firing.

Note: No engagements will be conducted during rearward movement.

- e. A specific period of time will be given for each move between bounds. The time will represent an average speed of 10 mph and will be established by the Chief Judge prior to the start of the competition. Time will start when the Chief Judge authorizes the platoon to begin movement, and will end when the last tank stops. Tanks must move in line. When, in the opinion of the Chief Judge, all tanks are firm on a bound, he may present targets without further commands.
- f. This sequence is continued up to and including the final bound. It will be seen from the foregoing that

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the platoon at the outset knows only the total number of targets to be engaged. Any number of targets to be engaged from a bound within the total may be presented at each bound.

- g. After completion of the final engagement on the final bound, the Chief Judge will announce "YOUR FRONT IS CLEAR. THIS CONCLUDES YOUR BATTLE RUN".
- h. At the end of each battle run, the platoon of tanks clears weapons. The Safety Officers personally check all weapons and ammunition and thereafter the Control Team checks the ammunition consumption. The tanks remain at the final bound until instructed by the Chief Judge to return to their units by the designated route.
- i. Empty casings may be jettisoned at any time during a battle run. These will be recovered by a detail provided by the Chief Judge. The spent casings will be delivered to the competing platoon upon completion of the battle run.

32. Misfires.

- a. In principle, a misfire is considered a warlike hazard which, subject to the maintenance of safety, should not in any way influence the continuation of the battle run. Engagements in which misfires occur will not be fired again.
- b. A misfire will be considered expended ammunition and will not count toward ammunition bonus points as unexpended ammunition.
- c. In the event of a misfire the following rules apply:
 - (1) Misfire drills will be carried out IAW national procedures.
 - (2) A misfire is to be reported immediately to Control and the tank commander will raise a yellow flag.
 - (3) Targets will continue to be presented and may be engaged by the other tanks in the platoon.
 - (4) If the misfire cannot be cleared before the order is given to move to the next bound, the tank concerned will conform to the platoon's movement, ensuring that its weapons are kept within arcs.

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- (5) If the misfire has not been cleared by the end of a battle run or occurs on the last bound, the platoon will remain on this bound until clearance drills have been completed.
- (6) The tank with the misfire may continue to assist the remaining tanks in the platoon by ranging and observing fire. The MG may be used between bounds.

33. Mechanical Failures.

- a. No extra time will be given for mechanical failures. Should any failure occur, the tank commander is immediately to inform Control and put up a yellow flag. The battle run will continue regardless of failures. This rule applies from the moment the platoon is called forward from the waiting area until the end of the battle run. When the fault has been rectified, the tank commander in question will obtain permission from Control before rejoining the battle run.
- b. There are three categories of mechanical failures within the meaning of these rules:
 - (1) Automotive failure (which prevents the tank from moving),
 - (2) Gunnery failure (which prevents the tank from firing), and
 - (3) Radio failure.
- c. Automotive failure. Special procedures will be followed for the cases given below:
 - (1) On a bound after the command "CARRY OUT ACTION" has been given: Engagements from the bound may be continued but before the remainder of the platoon may move to next bound, weapons of the tank in question are to be made safe and Control informed.
 - (2) Between bounds: The platoon will be halted by Control until the weapons of the tank in question have been made safe and Control informed. The remaining tanks in the platoon may then continue the battle run on order from Control.
- d. Gunnery failure: It must not prejudice the movement of the platoon and the tank in question must conform to

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the movement of the platoon or make weapons safe and remain on a bound when the remaining tanks move. The decision is to be made by the Platoon Leader who must notify Control.

- e. Radio failure: The tank must make weapons safe and must not move or take further part in the battle run until communications have been re-established.
- f. MAKE SAFE: Within the meaning of these rules, "MAKE SAFE" requires all weapons to be cleared and, in the case of tanks using fixed main armament ammunition, breeches are to remain open. In the case of separated ammunition, the breech is to be opened and the charge removed from the chamber.
- g. Target heating device failure: There will be no consideration given or grounds for protest should a target heating device fail to heat a target. The crew will continue with the engagement using normal target acquisition procedures.

34. Cease Fire. The Chief Judge has full authority to stop firing at any time for reasons of safety, bad weather or range fires. The Chief Judge is to announce officially when firing is to recommence. The visibility will be determined by the Chief Judge who will assess the clarity of a target farther away than the targets to be fired upon. Crews whose firing is interrupted by a "CEASE FIRE" will continue the battle run from the point at which they were stopped.

35. Daily Firing Changes.

- a. The Committee of Control can require additional platoons to fire each day in the interest of affording as many crews as possible the opportunity to compete. When it is necessary, Team Captains will be given sufficient advance notice to ensure the availability of crews at the required time.
- b. The Committee of Control, after consultation with the Chief Judge may, because of lack of firing time, prescribe a reduction in the number of engagements to be fired by each relay. When this is necessary, the Team Captains will be informed of the reason for the reduction and the Committee of Control will announce the total number of engagements to be fired by each relay.

36. Termination of Competition.

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- a. The end of the competition will be declared on the last day, even though all relays may not have had the opportunity to fire.
- b. If, due to an excessive loss of firing time, all platoons have not completed their battle runs, the final team score will consist of the scores earned by the maximum equal number of platoons in the order they competed per Army Group Team. A minimum of one relay must have been fired to constitute a competition.

37. Announcement of Results.

- a. After each battle run the scores are to be verified by the Committee of Control and then released to the Host Army Group for posting on the master scoreboard. An example of the master scoreboard is at Annex G.
- b. In case of a tie, the greater number of successful main armament engagements will decide the winning team. If the number of successful engagements are the same, the team which had the greater number of time score points shall be declared the winner.

38. Protests.

- a. Protests may be lodged only by the Army Group Team Captain to the Chief Judge after the termination of the battle run.
- b. There will be no conversation between the Team Captain/Unit Team Leader and the Platoon Leader from the command "MOVE TO BOUND ONE" until the termination of the battle run.
- c. The window for protest for each platoon will end two minutes after termination of the final engagement is announced by the Chief Judge (see para 31). The details of the protest must be presented by the Team Captain to the Chief Judge within five minutes following the end of the two minute protest window.
- d. The Team Captain, Unit Team Leader, and Platoon Leader may confer during the protest window to determine the necessity and validity of entering a protest. Two way communications will be provided between the Unit Team Leader and the Platoon Leader. If the Unit Team Leader, having discussed a potential protest with the Team Captain and having been advised by him, still insists on placing or withdrawing a protest, then the

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Team Captain is obliged to represent the wishes of the Unit Team Leader to the Chief Judge.

- e. Protests must be discussed with all national judges. However, national judges of the protesting platoon will be excluded from the vote on the protest. Protests must be decided upon unanimously by the voting judges; otherwise, they must be forwarded to CATCC. The decision of CATCC is final.
- f. If a protest is upheld and a platoon is allowed a second battle run, it should be carried out after all other platoons have completed their battle run.
- g. The Chief Judge will provide a suitable area for the Team Captain and Unit Team Leader to observe the battle run.

F. JUDGING.

39. General Remarks.

- a. The competition is to be judged by the Chief Judge and a panel of national judges.
- b. Each nation (BE, CA, GE, NL, UK and US) is to provide two judges. They will be neither members of the Committee of Control, nor members of a competing team.
- c. The organization, deployment, and rehearsal of the judging staff, safety officers, and control teams is the responsibility of the Chief Judge.

40. Safety Officers. The participating nations are to provide Safety Officers or NCOs for the competition as requested by the Chief Judge. These individuals will be officially designated as "Canadian Army Trophy Competition Safety Officers". They will be briefed as to their duties by the Chief Judge.

41. Control Team. A Control Team will be established to assist and be responsible to the Chief Judge for various competition control measures. The Chief Judge will request assistance from the participating nations to carry out duties as follows:

- a. Zeroing Range: The Safety Officer and range staff will allocate zeroing times, control firing and pass movement instructions to competing platoons prior to departure for the waiting area.
- b. Waiting Area: Control staff will check personnel identification, vehicle identification and carry out the

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ammunition count. They will prepare the initial portion of the Ammunition Score Sheet to be passed on to the Safety Officer. Crew commanders will countersign the Ammunition Score Sheet.

- c. Movement: The control staff will escort the competing platoon both front and rear with vehicles equipped with flashing lights from the waiting area to the battle run range at a safe speed based on the traffic conditions.
- d. Battle Runs: A Safety Officer will follow each tank along its lane during the run to ensure that safety is observed and note the rounds fired. At the end of the run, after the Safety Officer check, the Control Team will count the ammunition remaining in each tank, complete the Ammunition Score Sheet, have them countersigned by crew commanders, and return these sheets to the Chief Judge. An example of the Ammunition Score Sheet is given at Annex H.

42. Rules and Procedures.

- a. For the conduct of the battle runs, the Chief Judge's decision is final.
- b. The Chief Judge has the discretionary power to stop any engagement at any time.
- c. The Chief Judge will designate timekeepers. These timekeepers will be provided by the participating nations as required by the Chief Judge.
- d. The Chief Judge will verify that no targets are left exposed from previous firings. If, during firing, a previous target remains unavoidably exposed, the Chief Judge will warn the platoons of its presence and location before the practice commences. He will instruct the platoons to disregard such a target.
- e. The Chief Judge will ensure that the puffs are sited correctly and that the appropriate targets are visible to the platoon.
- f. The judges will produce a Judges' Platoon Score Sheet for each battle run. They will fill in their score sheets, as the battle run progresses, and apply the scoring rules described in Section G. After each battle run, the judges will confer and go down the range to confirm the hits on all main gun and MG targets. These Judges' Platoon Score Sheets will be

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handed over by the Chief Judge to the Committee of Control after each battle run. An example of a Judges' Platoon Score Sheet is given at Annex I.

43. Target Failures.

- a. A target failure may arise from:
 - (1) Faults in the target system; and
 - (2) Shooting.
- b. Target failures during static shooting due to faults in the target system
 - (1) These may include:
 - (a) The target not being indicated as described in para 26.j 2);
 - (b) The target being only partially displayed; or
 - (c) The target not appearing at all.
 - (2) In any of these cases, the Chief Judge will order "STOP, STOP, STOP". The engagement will be cancelled and any ammunition expended will not be counted and will be replaced, if necessary, at the most convenient time. The decision of the judges will be passed over the radio to the tank crews, who will be given at least 15 seconds before the fresh targets are presented.
- c. Target failure during static shooting due to shooting.
 - (1) Indication: A round fired falls minus and earth etc., from it knocks down, destroys or drastically alters the shape of the target, or a round cuts the target wire plus or minus of the target.
 - (2) Remedial Action: The shoot is stopped after the engagement and the crews are warned that a fresh target will be presented. This target will be at roughly the same range as the original target, but need not necessarily be presented immediately following the occurrence nor even on the same bound. However, when it is presented, the platoon will be warned just prior to the presentation that it is the replacement target and will be told the amount of time remaining within which it may be

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engaged. No extra ammunition is granted in this case. All or any of the tanks in the platoon may engage this target.

d. Target failure during movement between bounds.

- (1) Target failures due to faults in the target system: The Chief Judge will order "STOP, STOP, STOP" and the whole engagement must be repeated. Ammunition for the main gun and machine gun will be replaced. The Chief Judge after explaining the situation, will order the platoon to continue the Battle Run and repeat that part of the Battle Run after the final bound.
- (2) Target failure due to shooting: The Battle Run is stopped after the movement to the next bound is completed. The Chief Judge, after explaining the situation, will order the platoon to continue the Battle Run. After completing the Battle Run, the Chief Judge will order the platoon to return to the rear bound where the failure occurred and then present a target for the remaining time in the engagement. Machine gun targets will not be engaged and ammunition will not be replaced. Prior to the rerun the Platoon Leader may request that the original run be scored and not accept the rerun. The Team Captain may not influence this decision.

44, Watering of Firing Points. In the interests of fairness and of affording equal opportunity to all platoons, all firing points on each bound will be watered before a battle run begins to reduce and equalize obscuration.

G. SCORING SYSTEM

45. Scoring Principles.

- a. The scoring system for main targets will be based on a significant number of points for achieving target hits, with a lesser number for speed of achieving hits and, if all main armament target hit, a bonus score for targets hit and ammunition remaining. MG scoring will be based on the percentage of targets knocked down.
- b. The following definitions are relevant to the competition:
 - (1) Successful Engagement: A successful engagement is one in which there is at least one hit on a target

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within the time limit laid down. This does not include splinters or ricochets. In cases of doubt, the Chief Judge has absolute discretion.

(2) Time Limit: This is the period of 40 seconds for the main armament targets, measured from the time that targets are fully upright. Any shot fired outside the time limit will be ignored in the scoring of that battle run.

c. A bonus will be awarded for hitting all main armament targets. A bonus will also be given for main armament ammunition remaining after completion of the battle run, providing all main armament targets have been hit within the time limit.

d. For MG shooting, only those targets that fall down will score on each of the MG target groups.

46. Allocation of Points. Points are awarded as follows:

a. Main Armament Shooting:

(1) Hit Score:

$$\left(\frac{\text{Total Targets Hit} \times 100}{\text{Total Targets}} \right) \times 100 =$$

(2) Time Score:

$$\frac{\text{Total Time to Hits} + (\text{Max Exposure Time} \times \text{Non-hits})}{\text{Total Tgts} \times \text{Max Exposure Time}} \times 100 = \text{Factor to be applied to reverse sliding scale Time Score Table}$$

NOTE: Any portion of a second registered will be counted as the next full second. As an example, 6 and 1/10 seconds will be counted as 7 seconds in determining the time to hit.

(3) Hit Bonus: For hitting all main armament targets. 500 points

(4) Ammunition Bonus: (providing all main armament targets are successfully engaged)

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$$\frac{(\text{Rounds Remaining})}{\text{Total Rounds}} \times 100 \times 40 =$$

b. MG Shooting Score: For each target that falls:

$$\frac{\text{Targets hit}}{\text{Total Targets}} \times 100 \times 20 =$$

If MG targets are engaged with the main armament, no points for this MG target group will be given.

c. Penalties.

- | | |
|--|-------------|
| (1) For not arriving at a bound in the specified time | 600 points |
| (2) For use of reserve ammunition without authorization, per round | 1000 points |

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47. Time Score Table.

% Factor	Points	% Factor	Points	% Factor	Points	% Factor	Points
3	8500	26	6545	51	4420	76	2295
4	8415	27	6460	52	4335	77	2210
5	8330	28	6375	53	4250	78	2125
6	8245	29	6290	54	4165	79	2040
7	8160	30	6205	55	4080	80	1955
8	8075	31	6120	56	3995	81	1870
9	7990	32	6035	57	3910	82	1785
10	7905	33	5950	58	3825	83	1700
11	7820	34	5865	59	3740	84	1615
12	7735	35	5780	60	3655	85	1530
13	7650	36	5695	61	3570	86	1445
14	7565	37	5610	62	3485	87	1360
15	7480	38	5525	63	3400	88	1275
16	7395	39	5440	64	3315	89	1190
17	7310	40	5355	65	3230	90	1105
18	7225	41	5270	66	3145	91	1020
19	7140	42	5185	67	3060	92	935
20	7055	43	5100	68	2975	93	850
21	6970	44	5015	69	2890	94	765
22	6885	45	4930	70	2805	95	680
23	6800	46	4845	71	2720	96	595
24	6715	47	4760	72	2635	97	510
25	6630	48	4675	73	2550	98	425
		49	4590	74	2465	99	340
		50	4505	75	2380	100	255

NOTE: For percentage factor, calculate only to whole percentage points, disregard all decimal places.

48. Theoretical Highest Score.

a. Per Platoon

(1) Hit Score	=	10,000 points
(2) Time Score	=	8,500 points
(3) Hit Bonus	=	500 points
(4) Ammunition Bonus	=	1,600 points

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- (5) MG Score = 2,000 points
- (6) Total per Platoon = 22,600 points
- b. Per Army Group Relay (5x22,600) = 113,000 points
- c. The Competition Relay Score Sheet is at Annex J.

H. ADMINISTRATIVE INSTRUCTIONS.

49. General.

- a. The Host Army Group will hold an administrative meeting at least four months prior to the competition.
- b. Administrative information will be published and distributed by the Host Army Group at least three months before the competition.

50. Organization.

- a. The Host Army Group will organize the competition as a normal field exercise.
- b. The Host Army Group will establish the format for the Team Reception, the Opening and the Awards Ceremonies.
- c. The Chief Judge will provide to the national representative of the Committee of Control the details of the personnel and equipment requirements to support the multi-national judging, safety, and control staffs at least sixty days prior to the administrative meeting mentioned in para 49.a.
- d. The Host Army Group will coordinate billeting for the Army Group Teams and their own support personnel.
- e. Annex K contains a detailed listing of support to be provided by the Host Army Group. It also lists those items of support that the Army Group Teams and individual companies are required to provide.

51. Guest Policy.

- a. Official guests from other NATO nations and organizations will be determined by CINCENT. Within the Central Region, official guests will be limited to three star generals and above, and senior national representatives. Division and brigade commanders of firing units will also be official guests.

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- b. The list of official guests will be submitted to CINCENT for approval NLT four months prior to the competition.
- c. The Host Army Group will provide a field ration meal on the last day of the competition for invited guests and participants. Individuals will pay for their own meal at no cost to the Army Group.

52. Transport and Accommodation.

- a. The Host Army Group is not obliged to provide transport or accommodation to anyone attending the competition.
- b. Accommodations for members of the Committee of Control will be arranged by the Committee Secretary.

53. Press Policy.

- a. The Press Policy will be Selective-Active. An Allied Press Information Centre (APIC) will be established by HQ AFCENT.
- b. The public information policy and public affairs plan will be issued by the HQ AFCENT Public Information Office four months prior to the competition.
- c. Facilities will be granted to accredited press reporters and photographers. They will not interfere with the competition.
- d. A competition brochure will be produced one month prior to the competition week by the AFCENT PIO. It should be in the national languages of the participating units.

54. Traffic Control. The Host Army Group is responsible for traffic control including pedestrians.

55. CAT 87 Milestones. The primary milestones for CAT 87 are listed at Annex L.

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ANNEX A

RECORD OF PAST COMPETITIONS

<u>YEAR</u>	<u>HOST NATION</u>	<u>PARTICIPATING NATIONS</u>	<u>UNITS</u>	<u>SCORES</u>
1963		1. Belgium	4th Lancers	+11,473
		2. Germany	Panzer Bn 83	+ 6,203
		3. The Netherlands	41st Tank Bn	+ 1,221
		4. Canada	Fort Garry Horse	+ 180
		5. United Kingdom	5th Royal Tank Regt	- 1,851
1964		1. Belgium (TIE)	4th Lancers	+ 8,425
		2. Germany	Panzer Bn 83	+ 8,005
		3. United Kingdom	11th Hussars PAO	+ 7,163
		4. The Netherlands	43th Tank Bn	+ 2,830
		5. Canada	Fort Garry Horse	+ 1,024
1965	Belgium	1. United Kingdom	The Royal Scots Greys	22,970
		2. Belgium	4th Lancers	20,860
		3. Canada	Fort Garry Horse	18,930
		4. The Netherlands	11th Tank Bn	17,000
		5. Germany	Panzer Bn 83	16,240
1966	Germany	1. United Kingdom	13/18 Royal Hussars QMO	27,070
		2. Belgium	4th Lancers	26,310
		3. Germany	Panzer Bn 324	23,920
		4. Canada	Lord Strathcona's Horse (RC)	23,810
		5. The Netherlands	101st Tank Bn	10,820
1967	United Kingdom	1. Canada	Lord Strathcona's Horse (RC)	28,200
		2. United Kingdom	15/19 The Kings Royal Hussars	24,570
		3. Belgium	4th Lancers	24,290
		4. Germany	Panzer Bn 83	22,930
		5. The Netherlands	41st Tank Bn	21,370
1968	The Netherlands	1. Belgium	1st Lancers	21,290
		2. Germany	Panzer Bn 33	20,430
		3. United Kingdom	The Royal Scots Greys	16,990
		4. The Netherlands	43rd Tank Bn	14,670
		5. Canada	Lord Strathcona's Horse (RC)	14,620

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ANNEX A

<u>YEAR</u>	<u>HOST NATION</u>	<u>PARTICIPATING NATIONS</u>	<u>UNITS</u>	<u>SCORES</u>
1970	Canada	1. United Kingdom	16/5 Queens Royal Lancers	29,250
		2. Germany	Panzer Bn 33/34	24,895
		3. Canada	Lord Strathcona's Horse (RC)	17,510
1973	Germany	1. Germany	Panzer Bn 83	31,465
		2. United Kingdom	Queen's Royal Irish Hussars	30,190
		3. The Netherlands	11th Tank Bn	21,885
1975	Belgium	1. Germany	Panzer Bn 84	33,525
		2. United Kingdom	Royal Hussars (Prince of Wales Own)	32,650
		3. Belgium	2nd Lancers	31,605
1977	United Kingdom	1. Canada	Royal Canadian Dragoons	21,020
		2. Germany	Panzer Bn 144	20,720
		3. Belgium	1st Lancers	19,230
		4. United Kingdom	17/21 Lancers	17,430
		5. The Netherlands	11th Tank Bn	17,360
		6. United States	2nd Bn 81st Armor	16,100
1979	Germany	1. Germany	Panzer Bn 284	39,749
		2. Belgium	2nd Lancers	36,778
		3. United Kingdom	4/7 Royal Dragoon Guards	34,687
		4. United States	2nd Armd Cav Regt	32,489
		5. Canada	Royal Canadian Dragoons	30,681
1981	United States	1. Germany	Panzer Bn 294	41,770
		2. Belgium	2nd Lancers	36,577
		3. United States	1st Bn 32d Armor	35,187
		4. Canada	Royal Canadian Dragoons	34,990
		5. United Kingdom	Queen's Own Hussars	34,840
		6. The Netherlands	41st Tank Bn	30,724

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ANNEX A

<u>YEAR</u>	<u>HOST NATION</u> <u>ARMY GROUP</u>	<u>PARTICIPATING</u> <u>ARMY GROUPS</u>	<u>UNITS</u>	<u>SCORES</u>
1983	Canada	1. CENTAG	Panzer Bn 293 Panzer Bn 153 1st Bn 32d Armor 3rd Bn 64th Armor Royal Canadian Dragoons	183,507
		2. NORTHAG	4th Lancers Royal Scots Dragoon Guards Panzer Bn 74 11th Tank Bn 2nd Bn 66th Armor	182,010
1985	NORTHAG	1. NORTHAG	2nd Lancers 2nd Bn 66th Armor Panzer Bn 24 43rd Tank Bn Royal Scots Dragoon Guards	190,755
		2. CENTAG	3rd Bn 64th Armor 3rd Bn 32nd Armor Panzer Bn 63 Royal Canadian Dragoons Panzer Bn 244	185,656

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ANNEX B

COMPOSITION OF CANADIAN ARMY TROPHY

COMMITTEE OF CONTROL (CATCC)

A. Chairman: Brigadier General Dr. D. Genschel, ACOS Policy, HQ
AFCENT

B. Secretary: Maj. (P) Ray Krause, AFCENT Project Officer

C. MEMBERS:

REPRESENTING

COL Darrell Dean	CA Government
LTC Pim Bos	HQ NORTHAG
MAJ J. Kennedy	HQ CENTAG
MAJ J.R. Bertrand	I BE Corps
LTC Bill Coupland	Canadian Forces Europe
LTC Juergen Fritsch	German Army Office
LTC Paul Horsting	I NL Corps
LTC Bill Bowles	RAC Gunnery Wing (UK)
LTC Jim Probsdorfer	US Army Europe
COL Erich Becker	Chief Judge (GE Army)

U N C L A S S I F I E D

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ANNEX C

CONTROL AND SAFEKEEPING OF THE CANADIAN ARMY TROPHY (CAT)GENERAL

1. The winning Army Group will be responsible for the control and safekeeping of the CAT between competitions. The Army Group may rotate the Trophy between the units that made up the team. Should the competition not be held in the present two year schedule the responsibility for control and safekeeping will revert to the Director of Armour, NDHQ, Ottawa.

RESPONSIBILITY

2. The winning Army Group will assume full financial and physical responsibility for the CAT and must take the necessary precautions to safeguard it while in its possession.

CONTROL

3. On receiving the CAT the Army Group will advise the Director of Armour, NDHQ Ottawa, of the location where it will be held. Should the Army Group decide to rotate the CAT between units this return must include the dates and units involved.

4. The winning Army Group will be responsible for delivering the CAT to the Host Army Group Project Officer prior to the next competition.

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ANNEX D

TERMS OF REFERENCE: ARMY GROUP TEAM CAPTAIN AND UNIT TEAM LEADERA. ARMY GROUP TEAM CAPTAIN

1. The Army Group Team Captain should be a serving Lieutenant Colonel of armoured troops - preferably in command.
2. He will be responsible to the Army Group Commander for the proper preparation of the Army Group Team, its performance at the competition and for the team's military conduct.
3. In particular, he will:
 - a. Be responsible for coordinating the activities associated with the competition of the participating Unit teams.
 - b. Be responsible for all reports, returns, movements and administration during the competition period and directly associated with the competition.
 - c. Select the order of firing for each of the platoons taking part in his team.
 - d. Be responsible for lodging protests during the competition with the assistance of the Unit Team Leader.
 - e. Act as the point of contact between the Army Group Team and the Chief Judge.
 - f. Act as the point of contact between the Army Group Team and the Host Army Group.

General Duties

The Army Group Captain should be the officer normally in command of the team, drawn from the national contribution to the competition.

He will be responsible to the Army Group Team Captain for the proper preparation, training, operational conduct and administration of the team, and for ensuring that the Army Group Team Captain is kept informed of all matters which may arise.

He will ensure that the Army Group Team Captain is the desirable liaison officer between the national team and the Host Army Group.

He will ensure that the Army Group Team Captain is kept informed of all matters which may arise, and will, as necessary, detail such matters to the appropriate staff.

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ANNEX D

5. He will be responsible to the Army Group Team Captain for the proper behaviour of his unit team.

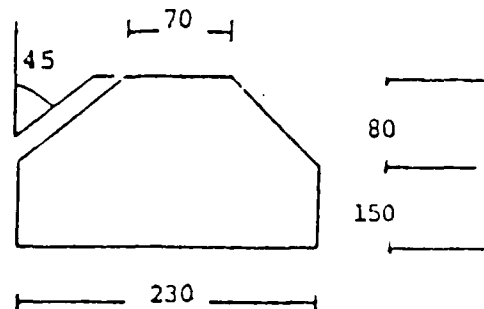
6. He will be responsible to arrange for wheeled vehicles with flashing lights to safely escort each tank platoon (front and rear) from unit lines to the zeroing range, waiting areas and return to unit lines after completion of Battle Run.

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ANNEX E

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TARGET DESCRIPTION

1. Main Armament:
ALL OF THE
TARGETS
IN PARAGRAPH 26
INCLUDING ALL
MOVERS, WILL BE OF
THIS TYPE



2. MG TARGET
FALLING PLATE



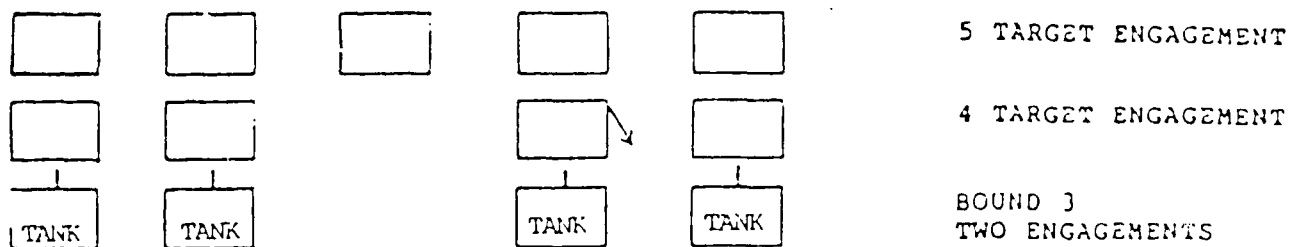
Approximately
30 x 30

3. ALL MEASUREMENTS ARE GIVEN IN CENTIMETRES

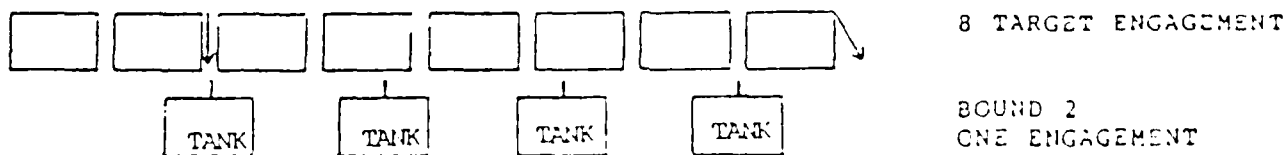
'EXAMPLE' BATTLE RUN LAYOUT

28 TARGETS

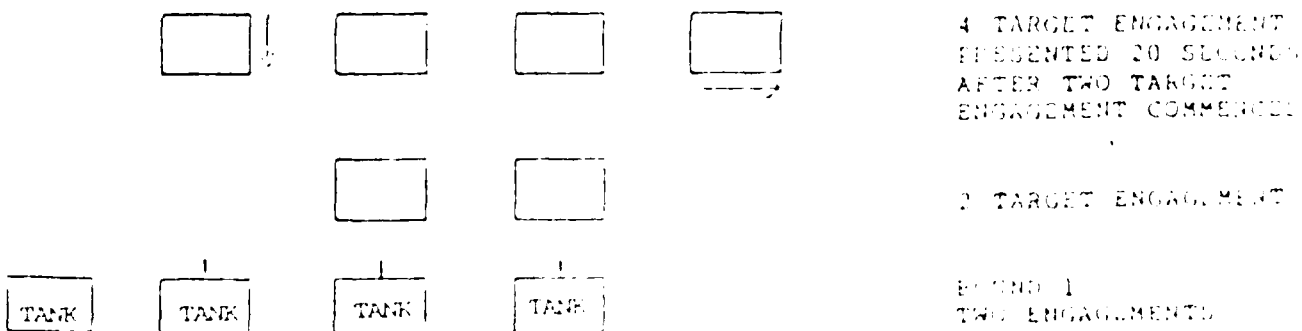
(FOUR TANK PLATOON)



BETWEEN BOUNDS 2 AND 3, THREE TANK TARGETS (ONE MOVER) AND 4 GROUPS OF 10 MG TARGETS TO BE ENGAGED ON THE MOVE.



BETWEEN BOUNDS 1 AND 2, TWO TANK TARGETS, AND 4 GROUPS OF 10 MG TARGETS TO BE ENGAGED ON THE MOVE.

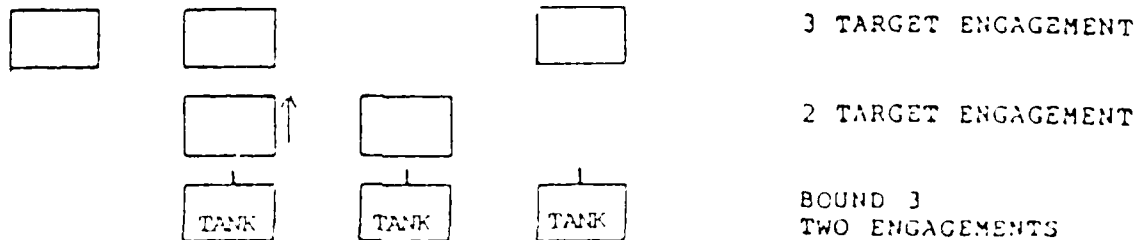


TANK A TANK B TANK C TANK D

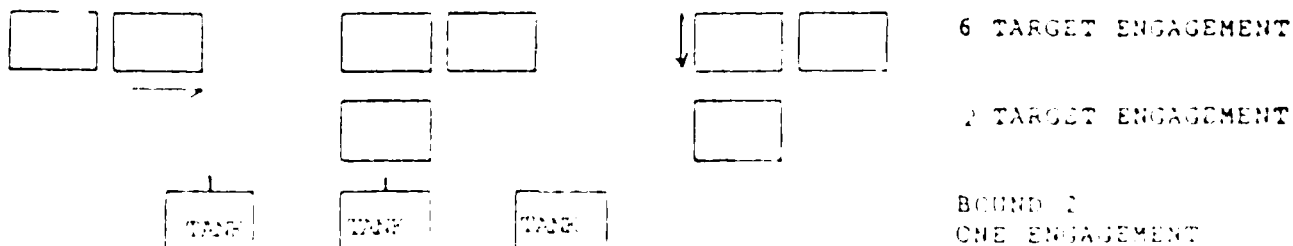
'EXAMPLE' BATTLE RUN LAYOUT

21 TARGETS

(THREE TANK PLATOON)



BETWEEN BOUNDS 2 AND 3, TWO TANK TARGETS (ONE MOVER) AND 3 GROUPS OF 10 MG TARGETS TO BE ENGAGED ON THE MOVE.



BETWEEN BOUNDS 1 AND 2, ONE TANK TARGET, AND 3 GROUPS OF 10 MG TARGETS TO BE ENGAGED ON THE MOVE.



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ANNEX H

CANADIAN ARMY TROPHY COMPETITION 1987
AMMUNITION SCORE SHEET

SECTION A

Tank Serial Number: _____
Tank Commander: _____
Tank Gunner: _____
Tank Loader: _____
Tank Driver: _____

Date: _____
Army Group: _____
Relay Number: _____
Platoon Number: _____

I. On tank in waiting area

Main Gun _____ Machine Gun _____
(Max = 14) (Max = 375)

Verification NCO: _____ (Signature)
Tank Commander: _____ (Signature)

SECTION B (COMPLETION RANGE)

Lane Number: _____
II. Used in Battle Run (Count as Fired) (Include Misfires) _____
III. On tank after Battle Run (Physical Count) _____
Control NCO: _____ (Signature)
Tank Commander: _____ (Signature)

SECTION C (SCORE COMPUTATION)

IV. Ammunition Saved (14-reserve-fired) _____

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ANNEX I

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CAT JUDGES' PL SCORE SHEET (DRAFT)

NOTE: Ammo Score Sheets Must Be Attached

DATE: _____

ARMY GROUP _____

RELAY NO: _____

PL NO: _____

NAME	NO	SERIAL NO	NAME	NO	SERIAL NO
CREW POSITION	NUMBER	NAME	NAME	DATE	TIME
COMO			COMO		
CUMMER			CUMMER		
LOADER			LOADER		
DRIVER			DRIVER		

NAME	NO	SERIAL NO	NAME	NO	SERIAL NO
CREW POSITION	NUMBER	NAME	NAME	DATE	TIME
COMO			COMO		
CUMMER			CUMMER		
LOADER			LOADER		
DRIVER			DRIVER		

NAME	NO	SERIAL NO	NAME	NO	SERIAL NO
CREW POSITION	NUMBER	NAME	NAME	DATE	TIME
COMO			COMO		
CUMMER			CUMMER		
LOADER			LOADER		
DRIVER			DRIVER		

NAME	NO	SERIAL NO	NAME	NO	SERIAL NO
CREW POSITION	NUMBER	NAME	NAME	DATE	TIME
COMO			COMO		
CUMMER			CUMMER		
LOADER			LOADER		
DRIVER			DRIVER		

NAME	NO	SERIAL NO	NAME	NO	SERIAL NO
CREW POSITION	NUMBER	NAME	NAME	DATE	TIME
COMO			COMO		
CUMMER			CUMMER		
LOADER			LOADER		
DRIVER			DRIVER		

NAME	NO	SERIAL NO	NAME	NO	SERIAL NO
CREW POSITION	NUMBER	NAME	NAME	DATE	TIME
COMO			COMO		
CUMMER			CUMMER		
LOADER			LOADER		
DRIVER			DRIVER		

NAME	NO	SERIAL NO	NAME	NO	SERIAL NO
CREW POSITION	NUMBER	NAME	NAME	DATE	TIME
COMO			COMO		
CUMMER			CUMMER		
LOADER			LOADER		
DRIVER			DRIVER		

LEGEND

A - TOTAL HITS
B - FIRST ROUND TO HIT
C - FIRST ROUND TO HIT

NO ENGAGEMENTS	HITS	NOV	NOV	NOV

NAME	Hit Score	Time Score	Hit Score	Time Score	Hit Score	Time Score	Hit Score	Time Score
TOTAL								

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ANNEX J

CANADIAN ARMY TROPHY COMPETITION 1987COMPETITION RELAY SCORE SHEETNOTE: Judges' Platoon Score Sheets must be attached.

Army Group _____ Relay Number _____

1st Platoon:

Hit Score	_____
Time Score	_____
MG Score	_____
Hit Bonus	_____
Ammo Bonus	_____
Penalties	_____
Total	_____

2nd Platoon:

Hit Score	_____
Time Score	_____
MG Score	_____
Hit Bonus	_____
Ammo Bonus	_____
Penalties	_____
Total	_____

3rd Platoon:

Hit Score	_____
Time Score	_____
MG Score	_____
Hit Bonus	_____
Ammo Bonus	_____
Penalties	_____
Total	_____

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ANNEX J

4th Platoon:

Hit Score	_____
Time Score	_____
MG Score	_____
Hit Bonus	_____
Ammo Bonus	_____
Penalties	_____
	Total

5th Platoon:

Hit Score	_____
Time Score	_____
MG Score	_____
Hit Bonus	_____
Ammo Bonus	_____
Penalties	_____
	Total

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ANNEX K

COMPETITION SUPPORT REQUIREMENTS

A. Support Responsibilities

1. HQ AFCEM

- a. Allied Press and Information Centre (APIC)
- b. Competition brochure
- c. Competition Awards, and Certificates

2. Host Army Group

- a. Range support for the competition and zeroing range
- b. Ammunition supply point security
- c. Medical support on competition range
- d. Protocol for competition range
- e. Communications for competition range and zeroing range
- f. Air plan for competition range landing pad
- g. Special functions
- h. Security of the competition range
- i. Accommodations for Army Group teams and support unit
- j. Provide a field kitchen on competition range to feed the judging staff and support personnel
- k. Invitations to official guests
- l. Traffic control

3. Army Group Teams

- a. Internal communications
- b. Coordinate team activities
- c. Coordinate team administration and support

4. Firing Units

N A T O U N C L A S S I F I E D

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ANNEX K

- a. Delivery and handling of ammunition
- b. Food/rations and feeding
- c. Fuel
- d. Transportation
- e. Laundry services
- f. Medical services
- g. Unit administration, financial and postal services
- h. Sport and recreation services

B. Special Functions

- 1. The Host Army Group will plan and coordinate:
 - a. Welcome Reception and team registration. No cost is to be incurred by the Host Army Group.
 - b. Opening Ceremony to be held on competition range the first day of the competition.
 - c. Awards Ceremony to include a field meal for participants and guests. No cost is to be incurred by the Host Army Group. Guests and participants will pay for their own meal.
- 2. The Host Army Group will coordinate these activities with HQ AFCEM.

C. Minimum Requirements for Range Support

1. Communications

- a. Tower
- b. Radio communications with safety and Team Captains and Platoon Leaders
- c. Public address systems
- d. English speaking Announcers will be used if possible.

N A T O U N C L A S S I F I E D

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ANNEX K

- e. Telephone - Range and Billets.
- 2. Tents/trailers
 - a. Committee of Control
 - b. Each Army Group Team
 - c. Judging organization
 - d. Shelter for VIP's
 - e. Field Kitchens
 - f. Beer Tent - provided by Host Army Group
- 3. Seating: Bleachers or grandstand seating for spectators
- 4. Latrine facilities - male + female
- 5. Scoreboard
- 6. Zero Range
 - a. Communications
 - b. Targets
 - c. Tents
- 7. Medical station
- 8. Water sprinkling truck
- 9. Trucks and personnel to back load empty ammo casings

N A T O U N C L A S S I F I E D

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1890.3/ACOPX/U 1177/86

ANNEX L

MILESTONES FOR CAT PLANNING

Date	Event	Action	Remarks
24-25 Feb 86 (year prior to competition)	CATOC Meeting to discuss: Updated Rules + Conditions Discuss support procedures	CATOC AG support OIC	At AFCEM
1 Mar 86	Submit long term budget; update short term	AFCEM, AGs	
15 Mar 86	Host Army Group (HAG) support/admin meeting Discuss: responsibilities, budget, requirements	AFCEM AG's Range Official	At HAG
7-9 Apr 86	CATOC Meeting Agree to any new rules and conditions	CATOC	At AFCEM
5-6 May 86	HAG Support Meeting	AFCEM Chief Judge AG's Range Official	At Range
26 May 86	Update/draft budget changes to AFCEM	HAG	
28 May 86	CINCENT Approve final rules and conditions	AFCEM	
18 Jun 86	Update Budget Forecast	AFCEM	
15 July 86	Publish/distribute rules and conditions	AFCEM	
15 July 86	HAG Support <u>Initial Plan/Taskings</u> published	HAG	

N A T O U N C L A S S I F I E D

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ANNEX L

MILESTONES FOR CAT PLANNING

Date	Event	Action	Remarks
5 Sept 86	Team Captains selected	Army Groups	Advise APCENT
23-24 Sept 86	HAG Admin. Meeting: Chief Judge presents final judges Support requirements	APCENT HAG Chief Judge	At Graf with Team Captains
15-16 Oct 86	CATOC Meeting	CATOC	At Graf
15 Dec 86	VTP list to HAG	Nations + AG	
15 Dec 86	HAG admin. order published	HAG	

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N A T O U N C L A S S I F I E D

1890.3/AOPEX/U117-7/86

ANNEX L

02 June 1986

MILESTONES FOR CAT PLANNING

Date	Event	Action	Remarks
2 Jan 87	AFCENT advised of competition range	COMCENTAG	
2 Jan 87	AFCENT notified of Corps/Ind. Bde units nominated for pool	Army Groups	
15 Jan 87	APIC Plan published	AFCENT	
2 Feb 87	Consolidated VIP list to CINCENT	HAG	
2 Feb 87	Unit narratives to AFCENT	AG	
17 Feb 87	HAG Admin. Meeting	HAG, AFCENT, Judge, Range	At CENTAG
2 Mar 87	Invitations sent	HAG	
22 Mar 87	Final unit rosters arrive AFCENT	AG	
1 Apr 87	CINCENT Draws Unit Names	AFCENT	
14-15 Apr 87	CATOC Meeting	CATOC	At Graf
1 May 87	CAT 89 Chief Judge Selected	NORTHAG	AFCENT notified
29 May 87	Letters of compliance arrive AFCENT	AG	
12 Jun 87	CATOC arrive at Graf	CATOC	

OP35

N A T O U N C L A S S I F I E D

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02 June 1986

190.3/ACOPX/U/147/86

NEX L

MILESTONES FOR CAT PLANNING

ite	Event	Action	Remarks
3 Jun 87	CATOC Meeting	CATOC	
5-19 Jun 87	Competition		
3 Jun 87	CATOC Meeting	CATOC	
3 Jun 87	CATOC depart Graf	CATOC	
9 Aug 87	CATOC members post-competition reports due to AFCEMT	CATOC	
9 Sept 87	Final CAT 87 Report Due	AFCEMT	
9 Sept 87	Final HAG After-Action Report Due	HAG	

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APPENDIX B
FINAL CAT 87 RESULTS BY ARMY GROUP

NORTHAG

PLATOON	HIT SCORE	TIME SCORE	AMMO PONUS	HIT PONUS	MG SCORE	PLATOON TOTAL	TEAM TOTAL	HITS
1 3 TP B RI	7500	4760	—	—	2000	14260	14260	18/24
2 3/4/ 324 PZ	9062	5610	—	—	2000	16672	30932	29/32
3 1/C/ 43 TK	9375	6885	—	—	2000	18260	49192	30/32
4 1/D/ 2-66	9062	6200	—	—	2000	17352	66544	29/32
5 3/A/ 4 IN	9062	5610	—	—	1750	16422	82926	29/32
6 3/D/ 2-66	9062	6200	—	—	2000	17352	100318	29/32
7 3/C/ 43 TK	8750	5865	—	—	1750	16365	116682	28/32
8 1/4 324 PZ	8750	5695	—	—	2000	16445	133128	29/32
9 1/B RI	7083	4590	—	—	2000	13573	146801	17/24
10 2/D/ 2-66	8750	6375	—	—	2000	17125	163926	29/32
11 1/A/ 4LN	9375	6120	—	—	2000	17495	181421	30/32
12 2/E/ RI	7016	4590	—	—	1800	14306	195727	10/24

CENTAG

PLATOON	HIT SCORE	TIME SCORE	AMMO PONUS	HIT PONUS	MG SCORE	PLATOON TOTAL	TEAM TOTAL	HITS
1 3/A/ 3-64	9062	5780	—	—	1950	15792	16792	29/32
2 3/D/ 4LP GAV	8750	6205	—	—	1975	16930	33722	28/32
3 1/C/ PCD	9062	6120	—	—	1975	17157	50879	29/32
4 2/4/ 124 PZ	9487	6035	—	—	2000	17722	68601	31/32
5 1/3/ 362 PZ	9375	6035	—	—	2000	17410	86011	30/32
6 2/A/ 3-64	8750	5950	—	—	2000	16700	102711	28/32
7 2/C/ PCD	9487	6375	—	—	2000	18062	120773	31/32
8 2/D/ 4LP GAV	9375	6630	—	—	2000	18005	138778	30/32
9 2/3/ 362 PZ	9487	6970	—	—	2000	18657	157435	31/32
10 1/4/ 124 PZ	10000	6715	500	500	1975	19690	177125	32/32
11 1/A/ 3-64	9487	7140	—	—	2000	18827	199952	31/32
12 1/C/ 4LP GAV	10000	7565	500	500	1925	20490	216442	30/32

APPENDIX C

SUMMARY OF SIMNET DEVELOPMENT EFFORT BEING

MANAGED BY DARPA

SIMNET

ADVANCED RESEARCH ON INTERACTIVE SIMULATOR NETWORKING

SIMNET OVERVIEW

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Defense Advanced Research Projects Agency
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Introduction

SIMNET is an advanced research project aimed at developing the *DoD technology base for large scale networks of interactive combat simulators (simulator networking)*.

If successful, this technology will dramatically increase the opportunity for units to practice collective, combined arms, joint war fighting skills in fully crewed, fully interactive, high quality simulators which cost 1/100th of today's simulators and which can be operated at a fraction of the O&S costs of a combat vehicle used for training.

SIMNET

Development of the generic DoD technology base for
networking hundreds of simulators.

- High attrition, war fighting, team skills.
- 1/100 cost of today's simulators (e.g., \$200 K vs \$20 M).
- Better acquisition of new weapon systems.

Background

While simulators have been shown to be effective for training selected military skills, it is often impossible to buy enough simulators to fully train the force because of their high cost. Further, because of the absence of a technology to network simulators, they have not been a factor in collective, combined arms, joint training.

SIMNET addresses both of these problems. Its high risk research is aimed at four high payoff areas. These payoffs are achievable because of recent breakthroughs in several core technologies. These technologies are combined in SIMNET to allow force-on-force, man-in-the-loop, free play combat exercises in simulation which require

HIGH PAYOFF AREAS OF THE SIMNET TECHNOLOGY

- Better and Cheaper Collective Training for Combined Arms, War Fighting Skills
- A Testbed for Doctrine and Tactics Development and Assessment in the Full Combined Arms Setting
- A "Simulate Before You Build" Weapons Acquisition Model
- A Contingency Planning and Dress Rehearsal Environment for Real World Crises

the same troop leading and command and control skills as in field exercises but which can be run on any terrain location in the world modeled in the simulation. The focus is to give all members of the combat team a massive dose of practice, from platoon/unit to the battalion/task force levels, and possibly higher.

CORE TECHNOLOGIES OF SIMNET

- Local and Long Haul Digital Networking
- Distributed Computing
- High Speed Microprocessors
- Hybrid Depth Buffer Graphics
- Special Effects Technology
- Selective Fidelity Design Principles
- Unique Simulator Fabrication Techniques

As used in SIMNET, these technologies are forged into a new technology which contains the characteristics shown below.

CHARACTERISTICS OF THE SIMNET TECHNOLOGY

- Man-In-The-Loop Simulation
 - Human vs. Human (not Human vs. Computer)
 - Free Play
- Low Cost Simulators
 - Full Crew
 - Reproducible in Large Quantity
 - Easily Reconfigurable
 - Manned by Typical Troops
 - Current With Weapon System
- Networkable
 - Task Organized and Employed as Combined Arms Teams
 - Modular (same technology used for a PLT in ANG armory or a BN on post)
- Vertical Slice of Command and Control
 - Company CP, Battalion TOC, Admin/Log, etc.
 - All Troop Leading Procedures

DARPA and the Army are using these technologies to field a research Testbed where simulator networking issues can be examined on a large scale. While SIMNET technology will have application across a wide range of joint military operations, the initial Testbed context will be the close combat heavy land battle featuring simulators for tanks, mechanized infantry fighting vehicles, fire support, maintenance, and command and control elements.

Two key technical issues will be addressed as the Testbed is constructed:

- (1) How can a large cluster of simulators be networked at a single site? [For example, a battalion sized tank heavy task force with 82 simulators (3 tank companies, 1 mechanized infantry company, scout platoon, command vehicles, FIST-V, air liaison officer, spares, etc.)]
- (2) How can these sites be connected for joint exercises? [For example, an OPFOR at one site engaging friendly force at another site thousands of miles away.]

Eventually, the Testbed will grow to over 320 simulators at 4 sites to investigate the many technical issues raised by these questions.

Modularity of the Simulators: Supporting the Reserve Component

SIMNET components have been designed to be self contained and modular by using powerful microprocessors assembled in *adistributed computing* architecture. The lowest common denominator is the single simulator. It can be operated completely by itself, just as a single tank can travel to a range and maneuver and shoot by itself. In this way one can think of the SIMNET simulators as full crew, stand alone, "surrogate" vehicles.

To create a network, two or more simulators are connected using a single coaxial cable (much like the cables used to connect cable TV service to a home). Only one other item is added to the network, no matter how many simulators are to be connected: A small set of microprocessors which are manned by combat support and service support personnel. SIMNET uses Apple Macintosh computers because they are simple to operate, inexpensive, and powerful.

The network grows by connecting new simulators to the network with more cable. Except for the initial Macintosh computers, no other computers are needed as the network grows from 2 to 82 or more simulators. This is because each new simulator has, built in, the extra computing power needed to handle the growth of the network which occurs when that simulator is added to the network.

This allows the same architecture and same simulators to be used for a platoon configuration in an Army National Guard armory as well as a battalion task force configuration on a large post. Combined with the fact that the SIMNET simulators are very low cost, this represents a breakthrough in providing an affordable combined arms training capability for the Reserve Component.

Technical Progress and Milestones

As of May 1986, DARPA has demonstrated two M1 simulators interacting on a local area network. This will be expanded into the construction of the SIMNET Testbed with key milestones shown below:

- 4Q FY86 - Two Platoons Installed at Ft. Knox
- 2Q FY87 - Ft. Knox Site Expanded to 1 Company
- 2Q FY87 - Ft. Benning Site Commences
- 1Q FY88 - Ft. Knox and Ft. Benning Sites Complete; 3rd Site Commences
- 2Q FY88 - 4th Site Commences
- 4Q FY88 - All Sites Completed
- 1Q FY89 - Networking R&D Completed

In addition to experimentation on the land battle scenario, DARPA will examine the technical issues of applying the SIMNET technology to networks of aircraft simulators, such as attack and scout helicopters and fighter aircraft. This investigation will be completed in FY86.

Other work is also underway to apply the SIMNET technology to the definition and acquisition of weapon systems. This is made possible because of the low cost of the simulators, the ease with which they can be modified, and the ability to network them to test the employment of a proposed weapon system in the tactical context in which it will be used, i.e., within the context of the combined arms setting. The manner in which this could be done is the subject of another paper.

Summary

The SIMNET advanced research project offers high payoff for training collective skills for combined arms joint teams because of the inherent capabilities of networking and because each of the new SIMNET simulators can be made affordable without compromising quality or capability. This is due to the advances made over the last few years in several core technologies, and the clever designs that exploit these technologies.

SIMNET is different from some types of gaming where computers play the opponents or part of the friendly force. In SIMNET, soldiers fight soldiers, not computers. They make the same mistakes, have the same emotions, and display the same initiatives as in real world exercises.

Finally, SIMNET allows tactics and doctrine to be tested in a man-in-the-loop environment against real opponents. The ease in modifying the order of battle, the capabilities of the opponent, the strength of logistical support, command and control procedures, and so forth, allow the evolution of sound, workable doctrine and tactics within the combined arms joint setting.

SIMNET is sponsored by the Defense Advanced Research Projects Agency (DARPA) in partnership with the United States Army. The work is being carried out by Bolt Beranek and Newman, Inc. (BBN) and Perceptronics, Inc., who are co-contractors, and Delta Graphics, Inc., which is a sub-contractor to Perceptronics. Delta Graphics is responsible for the CIG (computer image generation) visual subsystem, Perceptronics is responsible for training analysis, overall system specification, and the physical simulators, and BBN is responsible for the data communication and computer-based distributed simulation subsystems. The project is a total team effort.

DARPA is the DoD agency chartered with advancing the state of the art in military technology by sponsoring innovative, high risk/high payoff research and development

SIMNET AS A COMBINED ARMS TRAINING TECHNOLOGY

The Requirement

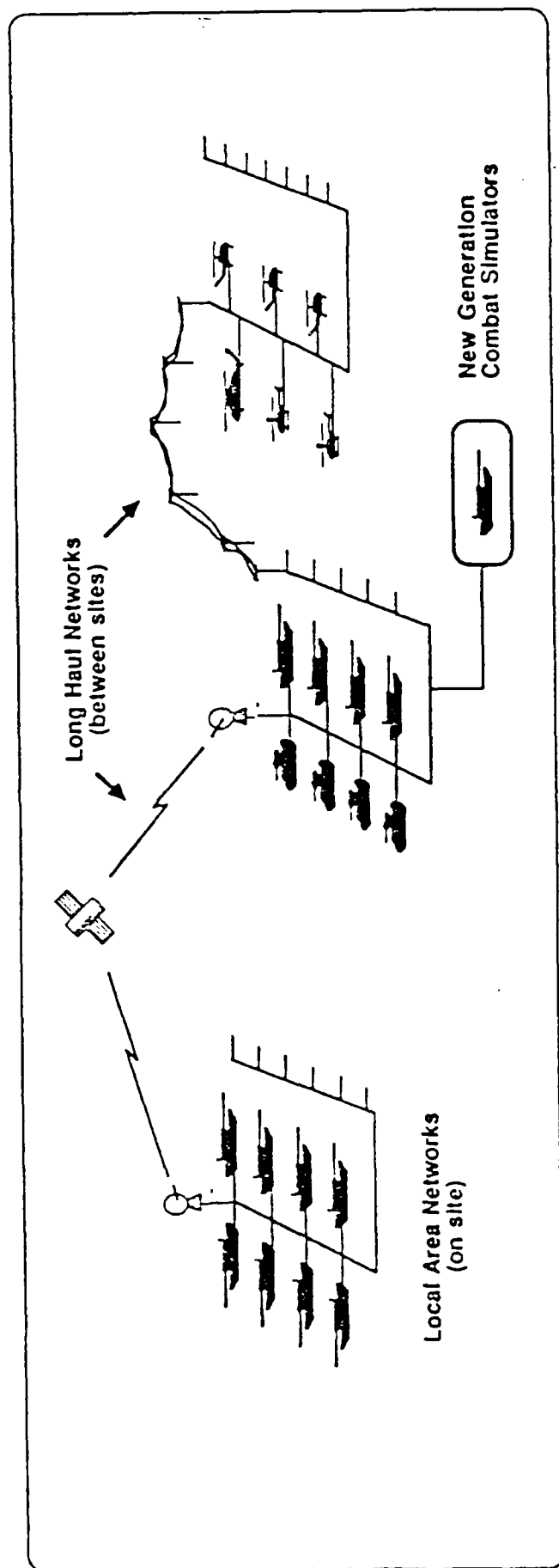
- The Combined Arms Team Must:
 - See The Enemy And The Battlefield
 - Move To See The Enemy And Fight
 - Suppress Enemy Weapons
 - Destroy The Enemy To Win
- To See, Move, Suppress, Destroy & Win Requires
 - Command and Control to Orchestrate the Battle
 - Combat Support (Artillery, Mortars, Air Delivered Fires)
- To Maintain and Exploit Success Requires
 - Maintenance
 - Ammunition Resupply
 - Fuel
 - Training In All Of The Above

The Solution

- Regular and Intensive Practice of the Combined Arms Team Using Interactive Simulator Networking Technology
 - Force-On-Force
 - Free Play
 - Man-In-The-Loop
 - Low Cost / High Tech / High Quality

SIMNET (Simulator Networking)

Networks of low cost, high quality simulators for practicing the combat team.



Low Cost Simulators

- Full Crew
- Mass Produced
- Easily Reconfigurable
- Manned by Typical Troops
- Current with Weapon System

Man-In-The-Loop

- Soldier vs. Soldier
- Competitive, Motivating
- Free Play, Make Mistakes, Learn

Networkable

- Organize as In Combat
- Modular, Plug In

Complete Fighting Team

- Combat Crews
- Command and Control
- Support (artillery, air, supply)

APPENDIX D
SIMNET TECHNICAL OVERVIEW

SIMNET Technical Overview

Approach, Issues, Architecture

Lt Col Jack Thorpe
SIMNET Program Manager
DARPA

8 September 1986

SIMNET Technical Approach

SIMNET research began in mid-FY83. Based upon DARPA's earlier experience with developing computer networks (ARPANET, as an example), it was decided that the best way to develop the SIMNET technology was to construct a prototype network of simulators to test and evaluate various technical approaches.

The size of the prototype network and its subject matter were based upon technical and military considerations.

The technical assessment was that a local area network (LAN) with about 80 - 100 simulators would present enough significant technical problems which, if solved, would be an advance in the state of the art.

A land battle was selected as the simulation environment...armor vehicles move slower than aircraft and therefore present less initial risk in terms of network update rate. They are also easier to simulate. Militarily, this sizing of the LAN corresponds to a battalion-sized task force. This permits the exercising of a full simulated battalion or several battalion components during SIMNET R&D activities.

To evaluate long haul network (LHN) technology, it was determined that four LANs should be constructed and networked. This would permit testing of several fully connected and partially connected network structures and would allow the study of reconfiguration algorithms when parts of the network were interrupted or lost altogether. All three types of

LHN media could be evaluated with such an approach (wideband satellite, dedicated digital land lines, and personal microwave). Militarily, this is the equivalent of four battalions. During SIMNET R&D, they would be able to engage in two-on-two combat, or any other partitioning desired by the commander.

The prototype SIMNET as it is currently planned, therefore, will be composed of four LAN sites networked with LHN technology. There will be 324 simulators in all. If all sites were active at one time, 1,400 troops would be involved.

Site Locations

The first LAN will be constructed at Ft. Knox, Kentucky, home of the Armor Center. It will be a tank heavy task force with 82 simulators:

- 54 - M1 Tanks
- 13 - M2 Cavalry Fighting Vehicles
- 7 - M3 Scout Vehicles
- 4 - Fire Support Vehicles
- 4 - Company Maintenance Vehicles

The first two platoons of simulators (8 M1 tanks) will be operational in September, 1986. The remaining simulators will be installed over the course of the next year.

The second LAN will be installed at Ft. Benning, Georgia, home of the Infantry Center. It will be a mechanized infantry heavy task force with 80 simulators:

- 51 - M2 Cavalry Fighting Vehicles
- 14 - M1 Tanks
- 7 - M3 Scouts

- 4 - Fire Support Vehicles
- 4 - Company Maintenance Vehicles

Installation of this LAN will commence in the late spring of 1987.

The locations for the third and fourth LANs will be selected by the Army, and the most likely candidates are Ft. Hood, Texas, and a European site. Additional tests of small unit installations will also be tested in National Guard and Reserve settings.

This schedule will permit the first LHN testing in the spring of 1987. When there are enough units at Ft. Benning to interact with the units at Ft. Knox, late summer 1987, the first field tests of LHNs will take place.

Planned Evaluations

Two types of evaluations will be conducted during SIMNET R&D.

Network evaluations will be conducted for all aspects of LAN and LHN connections, testing network protocols, failure recovery, cost, and so forth.

Training evaluations are also planned to assess the training effectiveness of this technology for unit training. The first concept evaluation test is planned following the two platoon installation at Ft. Knox. Test participants have already been identified and a test plan published. This test will determine (1) if troops can use the simulator the same as they use the combat vehicle in terms of

moving, shooting, communicating, navigating, and maintaining, and (2) are team skills improved. Two other training evaluations are scheduled, one for company level and the other for battalion level tasks.

Completion of SIMNET R&D

All four LANs and LHNs will be installed and all tests completed in 1989. At that time DARPA will turn the sites over to the Army to be used for training. However, this schedule might be impacted by other experiments connecting helicopter and fixed wing aircraft to the land network. See below.

Other SIMNET Projects

AIRNET

DARPA believes the SIMNET technology will have application for aircraft and naval combat vehicles as well as land vehicles. If a network of aircraft simulators can be constructed, for example, then land and air networks could be internetted to permit practice of airland joint operations. DARPA's long range goal is exactly that.

To this end, DARPA is currently studying the networking of Army scout and attack helicopters. This is more challenging than land vehicles because of the faster changes in position of aircraft requiring higher update rates on the network, and the faster changes in the visual environment requiring more capable graphics

computers in the simulators themselves. It is easier than the land network because there are usually an order of magnitude less aircraft in a typical battle, so networks would be smaller.

A feasibility study was completed in March, 1986, with a positive conclusion about using SIMNET technology for helicopter simulators. DARPA is waiting for an Army decision about a joint R&D program to construct a prototype system of scout and attack helicopters. Further, DARPA is teaming with the Air Force to study the same types of technical problems for adding fixed wing fighter aircraft to the network. Doing the same for naval air and sea forces is simply a matter of time.

Developmental SIMNET

Because SIMNET simulators are relatively inexpensive (\$200K vs \$20M) and can be easily modified, DARPA has speculated that they would be good candidates to evaluate proposed modifications to actual weapon systems or concepts for new weapon systems. Further, because they can be networked, whole fighting units of these modified weapon systems can be tested in teams against other base line weapons living elsewhere on the network.

Testing this premise is the objective of the Developmental SIMNET facility being planned for Ft. Knox as an offshoot of the basic SIMNET prototype LAN.

The Ft. Knox Developmental SIMNET facility will be a simulator skunk works which will have

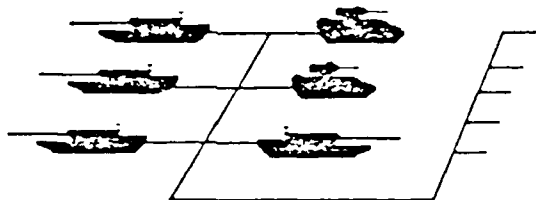
between 16 - 20 simulator skeletons capable of rapid configuration into simulated weapon systems. As new concepts are tested, researchers will collect data usually missing in most weapon development programs: How difficult will the operation of the new weapon be to train? Are troops with special qualifications needed? Given the interaction between operator behavior and the logistics model, what is the expected failure rate for components? What is the expected MTBF for these components? Are current tactics and doctrine suitable? Do typical troops using the new weapon in a combat team win any more or less against base line troops?

If SIMNET technology contributes to answering these questions, then interactive simulation networking will (1) give rise to a new model of weapon systems development in which simulation drives the developmental process, (2) allow typical troops to influence the design and evaluation process, and (3) result in a process where the training system for a new weapon system is completed before the first production system rolls off the assembly line, instead of several years after.

DARPA intends to test these concepts through FY89 at which time the Developmental SIMNET facility will be turned over to the Army.

Further Details - Technical Objectives

Technical Objective #1: Local Area Networking (LAN) of a Large Number of Simulators



This issue concerns whether LAN technology (such as the commercially available Xerox Ethernet) can support a cluster of simulators at a single site. In the near term, we are interested in clusters as small as 2 simulators and as large as 100, the size of many military teams/task forces. Eventually SIMNET research will study the technical problems of assembling even larger clusters.

As an example, the LAN cluster scheduled for the U.S. Army Armor Center at Fort Knox will have 82 simulators simulating a tank heavy battalion task force featuring M1 tanks, M2 and M3 Bradley fighting vehicles, fire support vehicles, company maintenance vehicles, and spares. It will be a fighting unit, just as if 82 combat vehicles were parked in a motor pool ready to be assigned to a commander conducting an exercise or going into battle.

The desired behavior of the LAN is similar to the old PBX telephone switchboards where an operator could connect any combination of individual phones into a variety of separate, non-interfering party lines at any time she wished.

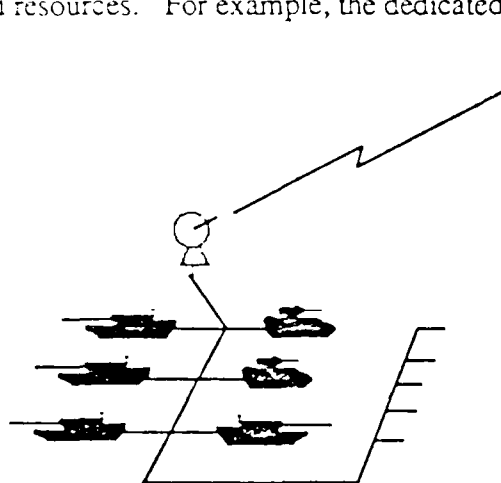
The SIMNET LAN will be similarly configurable. On a Monday morning the commander might have four new crews mount their tanks, initialize the tanks into four separate areas of the terrain data base, or even into four data bases of completely different terrain types, and practice single crew drills. At the same time, two platoons might be initialized into another area where they can practice flanking maneuvers on one another, and somewhere else a full company is initialized with combat support from a fire support center (mortars, artillery, and close air) and practice orchestrating a deliberate attack on a position defended by a dug in smaller force. On Tuesday, the commander might wish to reconfigure the network in an altogether different way to satisfy other training objectives.

The technical issues for SIMNET LANs include the format of the message protocols between simulators, the update rates needed for certain levels of activity, synchronous vs. asynchronous architectures, keeping an updated model of the complete world (terrain and objects on the terrain) at each simulator during periods of peak network saturation, expected types of network failures, and how to resume an ongoing exercise following short (< 0.5 sec) and long (> 1 min) interruptions.

Technical Objective #2:
Long Haul Networking (LHN) of Several LAN Sites

Once SIMNET LAN technology is developed, research will focus connecting LANs using long haul networking technology. The ability to connect sites impacts several military training problems:

- Many military training sites have limited resources. For example, the dedicated

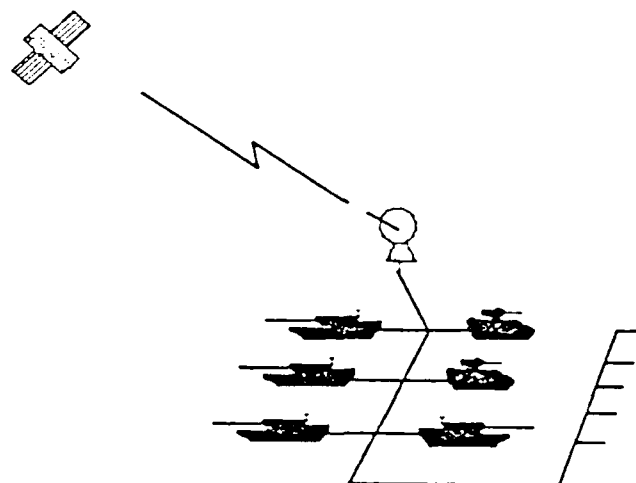


aggressor (OPFOR) battalion from the National Training Center is a critical resource. LHN technology would permit networking the OPFOR on a daily basis with various CONUS and non-CONUS units for training typical troops against this seasoned "Soviet" force. Today these field units have to deploy to the NTC for such training, now once every 18 months.

- Nearly all Reserve forces and many of the active duty forces in Germany are dispersed and rarely get to practice in mass. Connecting these locations by LHN will allow larger team practice on a regular basis without having to physically move to a common

maneuver area. The availability of these maneuver areas is decreasing.

- In the event of war, some CONUS units, particularly Reserves, are planned to round out combat units already on station in Europe or Korea. Presently, they rarely get the opportunity to practice with one another on their assigned terrain. LHN can provide one way to allow such practice.

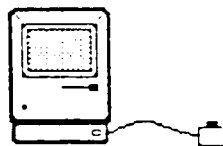


SIMNET will study three types of LHN systems: Dedicated digital land lines, wideband satellite, and personal microwave. These systems typically have less bandwidth than LANs (1-3 MBits/sec vs. 10 MBits/sec) but the principle difficulty is the time delay getting from LAN gateways onto the LHN and back again into the receiving LAN. While such delays are not serious for normal digital communications, they are potentially troublesome for real time gaming where the actions of one player on one LAN interact directly with those of another player on another LAN.

For example, one gunner (LAN #1) sees an opponent 1 km away (LAN #2). He aims, fires, and expects to see the proper effect (the opponent blowing up). If there is substantial delay, not only might the results of the engagement be incorrect, but the players would perceive a breakdown in "real timeness" and degraded pacing of their crew drills would be introduced.

The research issues for LHN include the types of gateway behaviors for different types of LHNs, intelligent routing of messages as a function of what simulators are interacting with each other, the costs of various types of LHN service, and security.

Technical Objective #3:
Simple Operation of SIMNET, and Providing
Combat Support and Combat Services Support



The two issues in this objective are separated into a computer science question (How can LANs and LHNs be operated without large control facilities, expensive operator training, and complicated procedures?) and a military question (Given all of these surrogate combat vehicles, how can the commanders be constrained in their tactical maneuver by the same types of real world

limitations in command, control, logistics, indirect fire, air support, and so forth?).

The first question is addressed by research on automatic and semi-automatic configuring of communication pathways that respond to an operator's direction to set up a particular game. The operator uses icon-based menus on Macintosh microcomputers. It appears that the networks will be easy to configure and monitor using this approach with little capital outlay for control facilities.

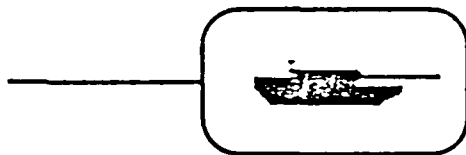
The second question is a military one, focusing on the limitations placed on all commanders in terms of combat service support (fuel, ordnance, repair parts and mechanics) and combat support (artillery, mortars, and close air support).

To constrain the commander in logistics, SIMNET has to have accurate models of the consumption rates of combat vehicles, failures of machinery (caused by incorrect operation, normal wear and tear, or combat damage), and use of ordnance. As an example, SIMNET simulators accurately model the factors that determine fuel consumption rates, such as the soil consistency and terrain slope which combines with throttle inputs, transmission gear, and weight to determine tractive effort, essential calculations for determining fuel usage. As fuel is burned, it is decremented from the vehicle's fuel supply and eventually the vehicle will have to be refueled or will run dry and stop.

Some of the issues researched as part of this technical objective concern the levels of accuracy needed for various aspects of the simulation, how these relate to specific training objectives, how radio networks can be simulated (voice comm is the primary control medium between the

combat arm and the support and services arms), how a tactical operations center can be simulated with its artillery and close air support duties, and how combat support and services support decisions are entered into the network.

Technical Objective #4 Development of Low Cost, High Quality Simulators



The final problem to solve involves the cost/performance of current simulator technology: Today's simulators cost an average of \$15 M - \$40 M each. At that unit cost for items that would reside on a network, simulator network technology itself is unaffordable.

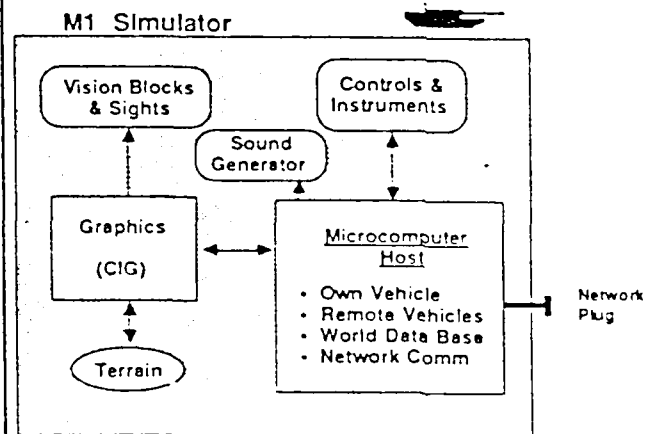
SIMNET research is examining this issue along several fronts, the objective of which is to develop the next generation of simulator technology. We want these simulators to outperform today's simulators yet be 100 times less costly.

The research issues being addressed include tightening the process by which a simulator requirement and engineering specification is developed (how training goals are translated into hardware specifications), how the principle of selective fidelity can be used in this process, inexpensive fabrication techniques for enclosures and controls, microprocessor hosts, special effects technology to increase realism, low cost graphics, and test and validation techniques to verify that training objectives have been met.

SIMNET Architecture

SIMNET is based upon the principle of distributed computing. The computation for the network is distributed among each of the simulators on the net and one additional microcomputer. In this regard, the architecture is completely modular. There is no central mainframe computer.

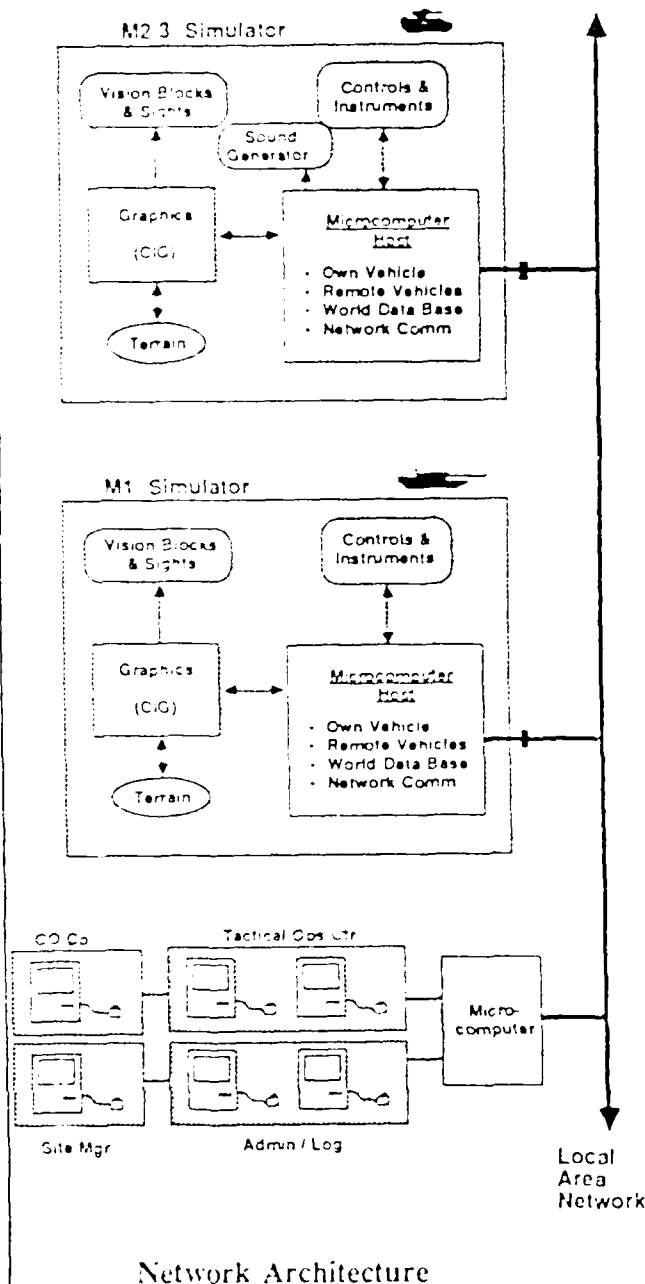
Each simulator is a stand alone unit which has hardware and software mechanisms for networking to other simulators when connected via coax cable. Each simulator has a host microprocessor, graphics, sound, controls and instruments, and a world terrain data base. When by itself, the simulator performs just like a single combat vehicle alone on a terrain patch.



Single Simulator Design

When two or more simulators are connected to form a LAN, the only computers that are added, no matter how large the network will grow, is one additional microprocessor used for housekeeping and from two to six Macintosh

microcomputers for user interface. That configuration defines a LAN. The extra computational power needed to accommodate the larger network configuration is provided by the marginal increase in computation brought by the new simulators on the network.



This approach permits the same architecture to support small installations of just a few simulators (like at a National Guard Armory) and large installations of 100 simulators at a major site.

A further attribute of this architecture is that when a given simulator fails, the network continues to operate, unaffected except for the loss of that crew from a gaming perspective.

For LHN operations, the LAN architecture is modified by the addition of gateways. These format information for transmission over the LHN circuits. Depending upon the type of LHN media, gateways behave in different ways and have unique constraints. SIMNET R&D will study these and will determine the most robust for the type of networking situation at hand.

APPENDIX E
AMOUNT OF SIMNET TRAINING

Platoons	Schedule		Complete	Number of		Battle	Runs	
	Days ¹	Hours ²		Aborted	3-tank	2-tank	Tgts up	
D/4/8 CAV								
1	14		58	0	1	0	1	
2	15		44	0	0	0	2	
3	14		44	0	0	0	1	
Total	16	214.5	146	0	1	0	4	
A/3/64 AR								
1	15		31	0	0	0	0	
2	13		29	0	0	0	0	
3	12		40	0	0	0	0	
Total	17	165.5	100	0	0	0	0	
D/2/66 AR								
1	9		42	2	2	10	0	
2	8		42	0	3	8	0	
3	9		47	1	0	3	0	
Total	16	90.5	131	3	5	21	0	

1. More than one platoon usually trained on each day.
2. Available hours were usually not allocated formally among platoons.

APPENDIX F

UNIT HOURS OF TRAINING IN PREPARATION FOR CAT

MONTHS

TYPE OF TRAINING	Aug-86	Sep-86	Oct-86	Nov-86	Dec-86	Jan-87	Feb-87	Mar-87	Apr-87	May-87	Jun-87	TOTAL	PERCENT
UNIT: D Co 4/B CAV													
CAT RULES AND CONDITIONS	0.00	0.00	0.00	0.00	0.00	2.00	2.00	3.00	0.00	0.00	0.00	7.00	1.11
SUP. TERRAIN BOARD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.93
CAT SUBCALIBER (7.62 mm)	0.00	0.00	0.00	0.00	0.00	6.00	6.00	30.00	0.00	0.00	0.00	42.00	5.73
CAT INBORE (50 cal)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00
M1 U-COFT	0.00	0.00	0.00	0.00	0.00	0.00	32.50	48.50	32.00	25.50	24.00	162.50	25.86
M1 SHINNET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	65.00	97.50	52.00	214.50	34.13
CAT BATTLE RUNS (105 mm)	0.00	0.00	0.00	0.00	0.00	0.00	64.00	0.00	42.00	0.00	46.00	152.00	24.18
TOTAL HOURS	0.00	0.00	0.00	0.00	0.00	8.00	98.50	84.50	133.00	122.50	166.00	623.50	100.00

UNIT: D Co 2/66 AR													
CAT RULES AND CONDITIONS	0.00	0.00	0.00	0.00	16.50	4.00	0.00	40.00	0.00	0.00	0.00	1.50	6.89
MANIPULATION/PRECISION GMPY	0.00	0.00	0.00	0.00	3.50	5.00	3.00	24.00	19.50	4.50	24.00	89.50	7.49
RANGE ESTIMATION	0.00	0.00	0.00	0.00	0.00	1.50	1.00	12.00	0.00	0.00	0.00	14.50	1.35
BOROSIGHT/ZERO	0.00	0.00	0.00	0.00	0.00	6.00	10.00	34.00	8.00	12.00	11.50	95.50	8.89
TANK CREW GMPY SKILLS TEST	0.00	0.00	0.00	36.00	3.50	6.00	0.00	0.00	0.00	6.50	6.00	57.50	5.35
TANK CREW PROFICIENCY COURSE	0.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00	0.00	0.00	0.00	7.00	0.65
SOP/SANDTABLE	0.00	0.00	0.00	7.00	9.00	15.50	16.50	24.00	19.00	25.50	14.30	121.50	11.31
CAT DRY FIRE	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.00	0.00	0.00	0.00	16.00	1.49
CAT MINIRANGE (7.62 mm)	0.00	0.00	0.00	0.00	7.00	17.50	0.00	24.00	7.00	22.50	5.00	82.50	7.68
CAT INBORE (50 cal)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00	7.00	0.65
M1 U-COFT	0.00	0.00	30.00	42.00	72.00	0.00	72.00	12.50	46.00	15.50	20.00	293.00	26.94
M1 SHINNET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	49.50	21.00	0.00	93.50	8.42
TANK TABLES VI-VIII (105 mm)	0.00	0.00	15.00	0.00	0.00	0.00	39.50	0.00	0.00	0.00	0.00	54.50	5.07
CAT LIVE FIRE (105 mm)	0.00	0.00	7.50	0.00	0.00	22.00	14.00	18.00	8.00	0.00	14.00	83.50	7.77
TOTAL HOURS	0.00	0.00	78.00	97.00	111.50	92.50	164.00	188.50	146.00	107.00	90.00	1074.50	100.00

UNIT: A Co 3/64 AR													
CAT RULES AND CONDITIONS	10.00	0.00	0.00	1.50	2.50	4.00	0.00	1.00	1.00	17.50	0.00	38.00	2.92
MANIPULATION/SNAKEBOARD	12.00	0.00	0.00	22.50	8.00	7.00	1.50	18.00	1.00	0.00	0.00	70.00	5.38
REVIEW RANGE 301 FILM	2.00	0.00	3.00	3.50	0.00	3.50	0.00	0.00	0.00	0.00	0.00	12.00	0.92
RANGE RECONNAISSANCE	37.00	45.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	82.00	6.31
BOROSIGHT/ZERO	15.00	0.00	3.00	11.50	4.00	7.00	4.00	9.00	1.00	16.50	0.00	70.50	5.42
TANK CREW GMPY SKILLS TEST	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.23
TANK CREW PROFICIENCY COURSE	51.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.00	3.92
PIPE COMMANDS/NOVEMENT REPORTS	14.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00	0.00	0.00	0.00	23.00	1.77
SOP/SANDTABLE	0.00	45.00	3.50	6.00	0.00	3.00	0.00	60.00	3.50	0.00	0.00	70.00	5.38
CAT DRY FIRE	21.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.00	1.63
CUMPRAT TRAINING, THEATER (22 CAL)	0.00	0.00	19.50	0.00	0.00	0.00	0.00	27.50	5.50	0.00	0.00	55.50	4.27
M1 U-COFT	18.00	0.00	126.00	32.00	6.00	77.00	12.00	12.00	103.50	0.00	0.00	181.50	20.27
M1 SHINNET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	103.50	62.50	0.00	166.50	12.73
TANK TABLES VI-VIII (105 mm)	45.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.00	3.46
CAT LIVE FIRE (105 mm)	0.00	45.00	0.00	0.00	14.00	0.00	0.00	30.00	0.00	64.00	0.00	151.00	11.77
TOTAL HOURS	225.00	135.00	155.00	77.00	32.50	101.50	17.50	175.50	222.00	159.00	0.00	1,091.00	100.00